PROCEEDINGS OF THE

1998 CHILDREN AT RISK CONFERENCE

Environmental Health Issues in the Great Lakes Region

July 8 and 9, 1998

The Regal Knickerbocker Hotel
Chicago, Illinois

Sponsored by

EPA Region 5
EPA Office of Children's Health Protection
and
Agency for Toxic Substances and Disease Registry

FOREWORD

The 1998 Children at Risk Conference: Environmental Health Issues in the Great Lakes Region was held at The Regal Knickerbocker Hotel in Chicago, Illinois, on July 8 and 9, 1998. The U.S. Environmental Protection Agency (EPA) Region 5, EPA Office of Children's Health Protection, and the Agency for Toxic Substances and Disease Registry (ATSDR) sponsored the 2-day symposium. The goals of the conference were to increase awareness and understanding of children's health issues in Region 5 and to create an effective forum for discussion between national experts and leaders on children's health issues and concerned citizens; federal, state, and local government employees; tribal representatives; research scientists; industrial groups; regional academicians; and environmental groups. All opinions expressed in this report are those of the conference speakers and do not necessarily reflect the opinions of EPA or ATSDR.

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Sponsorship for the Children at Risk Conference was provided by EPA Region 5 Waste, Pesticides and Toxics Division, the Great Lakes National Program Office, the Agency for Toxic Substances and Disease Registry, and EPA Office of Children's Health Protection.

Opening Session
Ms. Michelle Jordan, J.D.
EPA Region 5

Ms. Michelle Jordan stated that the protection of children is both a regional and national priority at the U.S. Environmental Protection Agency (EPA). Children are more susceptible to environmental threats because their systems are developing, and they proportionately eat more food, drink more fluids, and breathe more air than adults. In addition, children play on the ground and have more hand-to-mouth contact. As a result, children are more exposed to environmental risks and less able to defend themselves from environmental threats.

The trends in childhood asthma, cancer, and lead poisoning are alarming. Asthma data indicate that 5 million children have asthma and that each year 600 children die and 150,000 children are hospitalized because of asthma. From 1980 to 1993, the death rate related to asthma increased by 78 percent. In addition, 8,000 children are diagnosed with cancer each year, and the incidence of childhood cancer has increased steadily over the last 20 years. With regard to lead poisoning, 940,000 preschoolers in the United States have elevated levels of lead in their bodies. In addition, 50 million older housing units contain lead, which is a principal source of lead exposure, especially among low income children. High blood levels of lead result in brain damage and learning disabilities.

In October 1995, EPA Administrator Carol Browner announced a national policy to evaluate health risks to children. The policy recognizes children as a priority and requires that health risks to children be considered in risk assessments and in establishing regulations. In 1996, EPA announced its national agenda to protect children's health. EPA committed to set standards protective of children's health, develop a scientific research strategy, develop new policies to address cumulative and simultaneous exposures to children, expand community-right-to-know for families, educate parents, provide additional environmental health information to health care providers, and provide necessary funding to address children's environmental health.

In 1997, President Clinton issued an Executive Order regarding the protection of children from environmental health and safety risks. The Executive Order requires EPA to establish a multi-agency task force to develop a federal research agenda, rules based on an understanding of children's health effects, and proposals to enhance public outreach efforts. EPA Administrator Browner also established the Office of Children's Health Protection (OCHP) in 1997. According to Ms. Jordan, OCHP views its role as a catalyst for institutionalizing the Executive Order and the EPA Administrator's policy and national agenda.

Ms. Jordan stated that she is proud of EPA Region 5's involvement with children's health issues. The EPA Region 5 Environmental Actions for Children's Health (REACH) workgroup aims to accomplish three goals: (1) identify problems that most affect children in EPA Region 5, (2) develop strategies to address these problems, and (3) develop a plan to implement the strategies. REACH consists of a Science subgroup and an Outreach subgroup that jointly developed an action plan to implement policies outlined by EPA Administrator Browner and in the President's Executive Order.

EPA Region 5's sponsorship of the Children at Risk Conference supports REACH's plan to increase awareness and understanding of children's health issues. Ms. Jordan expressed her desire to establish communications at the conference between EPA and other institutions and organizations that could and in future collaborative efforts to promote children's health.

Ms. Michelle Jordan is Deputy Regional Administrator of EPA Region 5. Along with the Regional Administrator, Ms. Jordan is responsible for managing the EPA Region 5 air, water, hazardous waste, and other pollution control programs. Prior to receiving her present appointment, Ms. Jordan specialized in environmental law at a private law firm. In addition, Ms. Jordan was Assistant Attorney at the Illinois Attorney General's Office.

Opening Session
KEYNOTE SPEAKER
Dr. Barry Johnson
ATSDR

Dr. Barry Johnson outlined the five parts of his presentation as follows: (1) a summary of statistical findings in the realm of children's health, (2) the toxicological differences between children and adults, (3) an update on specific toxicants, (4) children's health issues related to hazardous waste sites, and (5) the Agency for Toxic Substances and Disease Registry's (ATSDR) children's health initiative.

Approximately 12.5 million people live within 1 mile of the 1,400 National Priority List (NPL) Superfund sites. Of this number, 3 to 4 million are children, including 1.4 million children who are 6 years old or younger. Studies indicate that populations of minorities, especially African and Hispanic Americans, are disproportionately higher than nonminorities near hazardous waste sites. Other studies indicate an association between hazardous substances or substances released from hazardous waste sites and birth defects. For example, birth defects have been associated with sites that are a source of solvent and polychlorinated biphenyl (PCB) exposure. PCBs and lead have also been associated with developmental delays. Another study reports lower fertility in persons exposed as children to large amounts of lead released from hazardous waste sites.

Dr. Johnson presented the differences summarized below between children and adults.

- Children are developing human beings uniquely vulnerable to environmental toxicants.
- In the womb, children are forming body organs, and it is during this period of organogenesis when injury leads to the most significant effects.
- Proportionally, children drink more water, eat more food, and breathe more air than adults.
- Children's frequent hand-to-mouth behavior increases the chance of ingesting contaminated dust and soil.
- Children's metabolic pathways are immature.
- Adolescents often enter the workforce, where chemical exposures are likely.
- Children have more future years of life to develop chronic diseases triggered by early environmental exposures.
- Children are completely dependent on adults for housing decisions, access to medical care, and risk management decisions.

Dr. Johnson provided an update on specific toxicants including lead, PCBs, methyl parathion, benzene, and trichloroethene (TCE). According to the Centers for Disease Control and Prevention (CDCP), 1.7 million American children had blood lead levels equal to or greater than 10 micrograms per deciliter (μg/dL) in 1990.

This figure has since decreased to 900,000 children, who are primarily Hispanic and African Americans living in metropolitan areas. Despite the dramatic reduction in cases of lead poisoning, which are primarily due to the removal of lead from gasoline and paint, several unanswered questions remain, including the contribution made by lead in soil and dust in home environments, the threshold in toxicity of lead in young children, and whether the 10-μg/dL action level will always be a standard against which all other exposures are compared.

ATSDR has worked with academic institutions to examine the effects of PCBs in fish tissue and the effects of prenatal PCB exposure on children's health. Dr. Johnson expressed ATSDR's belief that the PCB story is the lead story repeated. Low-level exposure to PCBs, like lead, has been associated with a reduction in Intelligence Quotient (IQ) and various developmental delays in cognitive processes.

ATSDR is working with EPA to examine the effects of methyl parathion on human health. A large number of children in Ohio, Mississippi, Tennessee, Louisiana, and Illinois, including the City of Chicago, have been exposed to methyl parathion in their homes.

Benzene and TCE are among 30 substances most often found in exposure pathways. Research has shown the leukemogenic properties of benzene. TCE has recently been classified as a likely human carcinogen. Studies indicate an increased rate of congenital defects in newborn babies when parents were exposed to TCE-contaminated drinking water supplies. TCE is a solvent often detected in groundwater contaminated by hazardous waste sites. However, TCE's effect on cancer rates has yet to be determined.

Dr. Johnson then discussed children's health issues relative to hazardous waste sites. At both Love Canal in New York and Lipari Landfill in New Jersey, state authorities observed that the percentage of low birth-weight babies increased over a 5-year period during which releases of hazardous substances were documented.

In another ATSDR study, PCBs were detected in the breast milk of Mohawk women who ate fish caught in the St. Lawrence River. Their reservation was downstream from factories that discharged effluent into the St. Lawrence River. Public health interventions designed by the Mohawk nation were successful in reducing the amount of PCB in body tissues.

In terms of lead poisoning, another study indicates that young adults in Idaho who had been exposed to large amounts of lead released from a smelter 20 years ago were found to have fewer children, have more

miscarriages, and be less fertile than a control group. The same young adults performed more poorly on neurobehavioral tests.

Another study shows that children living near a municipal waste incinerator have a three-fold increased risk of lower respiratory tract infection.

Under ATSDR's initiative, which was established in 1995, the term "children" refers to infants, children, and adolescents who are 18 years old or younger and, when appropriate, the entire gestation period. An advisory committee of 24 advocacy groups advised ATSDR on how to initiate the program. The advisory committee recently signed a Memorandum of Understanding with EPA to begin several collaborative projects related to children's health.

Accomplishments of the initiative so far are summarized below.

- Sections specific to children's health have been added to ATSDR's toxicological profiles.
- CDCP is conducting studies of autism related to exposure of hazardous substances.
- Funds have been established for three pediatric referral units where persons living near hazardous waste sites can be referred for pediatric evaluation.
- The National Cancer Institute and ATSDR have established a Children's Cancer Registry.
- Numerous case studies are being updated to target the needs of pediatricians and other children's health care providers.
- An exposure registry program has been established that specifically addresses children.

Dr. Johnson concluded by asserting that the health of our children represents a significant concern to ATSDR.

Dr. Barry Johnson is Assistant Administrator of ATSDR in Atlanta, Georgia. As Assistant Administrator, Dr. Johnson is responsible for ATSDR's programs and overall direction. He holds the rank of Assistant Surgeon General in the U.S. Public Health Service (PHS). Dr. Johnson is the recipient of numerous PHS medals for his work.

Opening Session
KEYNOTE SPEAKER
Dr. Lynn Goldman
EPA Headquarters

Dr. Goldman stated that the legacy of children should be everyone's concern. Although concerned about the intellectual and financial legacy of children, people are generally not concerned about children's environmental legacy. Exposure to harmful agents in the environment could set children up for long- term adverse health effects, and environmental degradation could affect their economic well being. We owe it to our children and grandchildren to provide a clean and safe environment.

Over the last 25 years, much progress has been made to ensure that the environment is cleaner and safer. Toxic pollution from industry is steadily declining, and fewer children are poisoned by lead. However, significant environmental hazards remain. For example, the number of asthma deaths among children more than doubled between 1980 and 1993. Poison centers reported more than 1 million toxic exposures or ingestions among children under the age of 5. Nearly 1 million children suffered from lead poisoning in almost totally preventable conditions. Certain types of childhood cancer are increasing dramatically for unknown reasons. It is known, however, that chronic exposure to thousands of untested industrial chemicals is increasing as the number and quantity of chemicals in the environment increase. In addition, there is growing evidence of chemicals disrupting endocrine systems and causing problems in sexual and reproductive development in animals and humans.

The Clinton Administration is striving to tackle these problems. An Executive Order signed by President Clinton in 1997 requires federal agencies to ensure that their policies and rules address the disproportionate hazards that may be felt by children. Although protection of children has always been a priority at EPA, it is even more so under the leadership of EPA Administrator Carol Browner.

EPA's OCHP is taking a lead to ensure that all EPA actions consider children's health and to coordinate research on children's unique susceptibility and exposure to environmental pollutants. In addition, a Joint Grant Program between EPA and the National Institute of Environmental Health will establish Centers of Excellence for research in children's environmental health throughout the country.

In 1997, EPA adopted stringent air standards to protect children. Dr. Goldman projected that when fully implemented, the new standards will prevent approximately 15,000 premature deaths; 350,000 cases of aggravated asthma; and 1 million cases of significantly decreased lung capacity in children.

EPA is dedicated to expanding citizens' right-to-know about environmental hazards in their communities. Arming people with information about hazards in their communities is one of the most powerful tools available to advance environmental justice, protect children, and achieve real environmental results. The Toxics Release Inventory (TRI) provides information to the public about toxic chemicals used and released by facilities. The TRI is available on the EPA webpage. Citizens and companies have used TRI information to reduce environmental pollution. Since 1988 when companies started reporting the release of toxic chemicals to their communities, facilities have reduced their emissions by more than 50 percent. The Clinton Administration has nearly doubled the number of chemicals reported in the TRI. In addition, EPA expanded the number of facilities required to report to the TRI by 30 percent. The primary problem with the TRI is that only chemical emissions exceeding the threshold limit of 10,000 pounds per year must be reported. However, persistent and bioaccumulative chemicals at lower concentrations could contribute significantly to environmental loading. As a result, EPA will propose a lower threshold limit for the TRI.

Dr. Goldman then focused on pesticides and the Food Quality Protection Act (FQPA) of 1996, which contains special provisions for protecting children. Previous pesticide legislation did not take into account the special vulnerability of children. Congress unanimously passed the FQPA, indicating that the American public wants safe food, especially for children, and wants children to be protected from exposure to pesticides in drinking water and water used for other residential purposes. The FQPA ensures that children are protected by requiring an additional tenfold margin of safety for children unless data are submitted that demonstrate no prenatal or postnatal risks to children. In addition, Congress has given EPA a tight 10-year schedule to review the 10,000 existing tolerances for pesticide residues on food. EPA anticipates reviewing one-third of these tolerances by August 1999. Several initial steps were established before the review began. For example, new methods have been developed to assess risk, especially cumulative risks. In addition, there is a need for establishing scientific criteria for dealing with the additional tenfold margin of safety for children.

A memorandum from Vice President Gore has guided the review effort by calling for strong science, extensive stakeholder participation, and a smooth transition. EPA will rely on scientific advice from the National Academy of Sciences to prepare its report on pesticides in infant and children diets. Several science advisory committees, such as a tolerances assessment advisory committee, have been established. Information on the committees' efforts are available on EPA's pesticide webpage.

Another issue of importance in protecting children and the public's right-to-know is the availability of fundamental information about the risks posed by chemicals. Nearly 3,000 chemicals in the United States are

imported or produced at a rate of more than 1 million pounds per year; these chemicals are considered high-production volume (HPV) chemicals. Of these HPVs, 43 percent have no available basic toxicity testing information and only 7 percent have a full set of basic toxicity information available. In addition, basic information is available for only about 25 percent of the chemicals present in consumer products. A chemical cannot be added to the TRI if there is no information available about the chemical. Lack of information about so many chemicals compromises the public's "right-to-know." On Earth Day 1998, Vice President Gore issued a challenge to industry to develop a complete set of basic information for all HPV chemicals. In turn, he called for EPA to ensure that industries that do not voluntarily aid in this effort be required to under a rulemaking effort to fill information gaps.

Endocrine disrupters are also of concern. In addition to establishing more stringent pesticide standards under the FQPA, Congress also established a program to screen and test chemicals that may be present in food for endocrine disruption potential. The Safe Drinking Water Act (SDWA) includes a similar requirement. Many chemicals had been observed to cause endocrine disrupting effects in animals. In addition, epidemiological trends have been identified that lack clear causative agents; the trends may or may not be due to endocrine disruption. Although great uncertainty is associated with the identification of trends, increases in breast cancer, prostate cancer, and testicular cancer have been observed. In addition, some studies show a decline in sperm count in some populations, and others show that girls are experiencing puberty at a younger age. The Endocrine Disrupter Screening and Testing Advisory Committee (EDSTAC), which consists of 45 experts, was convened by EPA to examine estrogenic, androgenic, and thyroid-related effects of certain chemicals. EDSTAC has designed a program to screen and test chemicals with endocrine disruption properties.

The lead issue is both a success and a continuing challenge. Most of the nearly 1 million children with unsafe blood lead levels are from low-income families living primarily in older housing units. Dr. Goldman urged state and local public health agencies to adopt EPA's new abatement and cleanup programs and called on states to take primacy of programs aimed at the reduction of blood lead levels in children. The public is invited to comment on recently-proposed revised standards for lead.

The real challenge is to stay the course to eliminate environmental disease among children. Despite the successes, challenges still remain. Screening programs for children at risk from lead poisoning still do not exist, nor do lead abatement cleanup programs to remove lead in low-income areas across the country. Dr. Goldman expressed her concern that people might give up the fight before it is won because of all that has been achieved for middle income families.

Many health care professionals misdiagnose children with lead poisoning, and others simply do not perform screening tests. Dr. Goldman urged health care professionals to make lead testing a priority, especially those working in low-income areas. Medicaid will now compensate blood lead testing, and children at highest risk of lead poisoning are generally covered by Medicaid.

In closing, Dr. Goldman stated that EPA has the responsibility to protect children and the fragile ecosystem. In addition, future generations, our species, and the sustainability of the environment and our race must be protected.

Dr. Lynn Goldman is Assistant Administrator of EPA's Office of Prevention, Pesticides, and Toxic Substances. She is a pediatrician and epidemiologist. At EPA, Dr. Goldman has promoted pollution prevention, reduction of risks from chemicals and pesticides to health and the environment, and expansion of the public's right-to-know.

Financial Impact of EPA Policy

Mr. Jeff Kindrai (Kenosha County Health Department, Wisconsin) asked if the described policy came from EPA or was a political campaign issue from President Clinton and Vice President Gore. Mr. Kindrai also asked for comment on the potential financial impact of the policy on industry in terms of compliance and government in terms of enforcement.

Dr. Goldman stated that the Clinton Administration has been very supportive of EPA and its efforts, especially in terms of ensuring a budget for EPA. In her opinion, all environmental accomplishments over the last few decades, including the FQPA, have been achieved only through bipartisan cooperation. The FQPA was passed unanimously by both houses of Congress. We all live in the environment and therefore all have a stake in the matter.

In terms of the financial consequences of the policy, Dr. Goldman stated an important EPA goal is to not only foster a clean environment but also a strong economy. EPA believes that the two go hand-in-hand. Some of the specific initiatives to promote a clean environment and strong economy are not expensive. For example, the basic testing data for an HPV chemical can be obtained for $200,000 to $300,000. Even if testing of all 3,000 chemicals were completed over a 3-year period, the cost would only be about 0.2 percent of the profit to an industry. Dr. Goldman regarded this as a barely noticeable "dent" and noted that it is a one-time investment. Basic chemical testing would give companies the ability to make better decisions about how certain chemicals should be used. Dr. Goldman prefers a strategy to increase prevention, improve citizens' right-to-know, and explore cost-effective means to achieve environmental protection rather than strategies that involve very expensive, "after-the-fact" cleanups.

Dr. Johnson began his response with the statement, "You can pay me now, or you can pay me later." Dr. Johnson stressed the importance of examining the long-term costs to human health and the effects on ecological systems instead of examining up-front costs. In addition, he stressed the societal costs of reduced intelligence, cognitive delays, and cancer, among other adverse health conditions. Dr. Johnson described an approach called "prevention effectiveness analysis" that examines long-term health and economic costs to the society and encouraged public health and environmental supporters to use this approach. Finally,

Dr. Johnson commented that pollution prevention is one of the most effective approaches in reducing long-term costs.

Safety Factors

Ms. Mary Lee Hultin (Michigan Department of Environmental Quality) asked whether the tenfold interspecies uncertainty factor already used in human health risk assessments is protective of children's health.

Dr. Goldman replied that it is not and stated that the 1993 National Academy of Sciences (NAS) report titled "Pesticides and the Diet of Infants and Children" contains clear evidence that a third tenfold factor is necessary to protect children. Although the interspecies tenfold factor is needed to account for all variability, including genetic variability, within our species from fetus through senescence, it does not address pre- and post-natal developmental risks. The NAS report states that a third tenfold factor should be added for this purpose.

Ms. Hultin then asked Dr. Goldman if she could break up the safety factors into, for example, one that addresses exposure more and one that addresses toxicity more, or if the expansion was just generally tenfold.

Dr. Goldman responded that it is a general expansion. If a smaller number is desired, it must be demonstrated that adequate information on both toxicity and exposure is available. Although the NAS report focuses on toxicity and pre-natal and post-natal developmental risks, FQPA states that adequate information on both toxicity and exposure is necessary to either reduce or remove the additional tenfold factor.

ATSDR-EPA Region 5 PCB Study

An unidentified audience member asked Dr. Johnson for more description of the study coming out in fall 1998 regarding PCBs and their developmental effects.

Dr. Johnson stated that during the last 5 years, ATSDR has worked with EPA Region 5 and several academic institutions to examine the effects of PCBs in fish tissue on the reproductive and neurobehavioral health of children prenatally exposed to PCBs. The research was conducted among fish-consuming cohorts from Michigan to New York. After 5 years of research and conferences, the research group concluded that PCBs passed into fetuses from mothers who consumed large amounts of fish did represent a significant hazard to

offspring. Dr. Johnson revealed that a two- to eight-point reduction in IQ, cognitive delays, and reduction in birth weight were observed in children exposed *in utero* to PCBs. A research paper will be published in the *Journal of Great Lakes Research* in September 1998.

Medical Waste Incineration

Ms. Liane Casten (author of a book about breast cancer and the environment) asked why there has not been much discussion on incineration when EPA has already identified medical waste incineration as a major source of dioxin. In addition, Ms. Casten asked about EPA's plans in terms of helping industries convert to safer medical waste disposal practices.

Dr. Goldman responded by identifying two approaches to resolve the incineration issue. First, the Clean Air Act calls for best available technologies to control emissions from medical waste incinerators. Secondly, EPA has initiated a pollution prevention effort with the American Hospital Association (AHA). EPA signed an agreement with AHA that requires hospitals to strive to eliminate the use of mercury. Dr. Goldman identified this as an example of pollution prevention because it reduces pollution at the source. She also called the agreement an effective effort in dealing with persistent bioaccumlative chemicals.

Ms. Casten then asked about the incineration of polyvinyl chloride (PVC).

Dr. Goldman expressed her belief that medical waste incineration controls will greatly impact general emissions, including emissions from the burning of PVC. PVC is a fairly controversial issue, and scientists at EPA and throughout the federal government are striving to understand the extent to which PVC incineration contributes to dioxin emissions. Dr. Johnson added that little is known about how municipal waste incinerators affect human health. One of the problems associated with incinerators is that once they are in place, performance is inadequately monitored. Dr. Johnson encouraged more research in this area.

Environmental Education

Dr. Jewel Crawford (ATSDR's Office of Urban Affairs) commented that as a primary care physician, she observed a low level of awareness of environmental concerns among physicians. Dr. Crawford asked if EPA had approached the American Association of Medical Colleges or medical schools to discuss including environmental education in the curriculum.

Dr. Goldman responded that EPA, ATSDR, the National Institute of Environmental Health Sciences (NIEHS), and the National Institute for Occupational Safety and Health (NIOSH), among others, have all supported medical education and training in environmental issues. For example, the Medical Research Council has conducted extensive studies and submitted recommendations on the importance of incorporating environmental education into the medical curriculum. Despite these efforts, however, training received by physicians, nurses, and other health care providers remains inadequate when it comes to environmental concerns.

Childhood Cancer

OVERVIEW/ EPIDEMIOLOGY

Dr. Leslie Robison
University of Minnesota Cancer Center

Dr. Leslie Robison presented a general overview of pediatric cancer, including epidemiological and etiologic issues. Childhood cancer is a rare disease and is generally defined as cancer occurring in children under the age of 15. Although these children represent a minority of the affected population (2 percent of cancer cases in the United States occurs in children), it is still an important public health problem. In the United States, approximately 7,500 children under the age of 15 are diagnosed with cancer each year. Approximately 1 out of every 630 individuals develop cancer by the age of 15. Cancer is the second leading cause of death in children and the leading cause of death among children from disease.

The Surveillance Epidemiology and End Results (SEER) program of the National Cancer Institute is the most extensive cancer registry in the country. Dr. Robison regards the program as the best source for determining cancer incidence and cancer trends in the United States. Dr. Robison presented age-specific, gender-specific, and race-specific (blacks and whites) data from the SEER program from 1974 to 1989. Based on these data, the highest cancer incidence rates occur in the first few years of life, after which there is a decline and then a gradual increase again during the adolescent years. In general, males have a higher incidence of childhood cancer than females. Leukemias and lymphomas also have a male predominance. In addition, whites have higher rates of childhood cancer than blacks in the United States, with leukemia being the most notable.

The distribution of childhood cancer in the United States differs from the distribution of cancer in adults. Almost 50 percent of all childhood cancer patients either have some form of leukemia or a tumor that affects the central nervous system. Acute myloid leukemia is the predominant form of childhood leukemia. By contrast, chronic leukemia, one of the most common types of leukemias in adults, represents only 4 percent of pediatric cancers. Brain tumors constitute 21 percent of childhood cancer cases. There are several cancers that occur primarily in children.

The treatment of pediatric cancer has improved over the years. Based on SEER data, the childhood cancer mortality rate has been declining steadily. Approximately 70 percent of all children with cancer survive 5 years after diagnosis; this survival rate is generally indicative of a cure because many childhood cancers regress. However, Dr. Robison stressed that 30 percent of children with cancer are dying. Although the mortality rate is decreasing because of very aggressive therapeutic approaches, an important concern is the

long-term health consequences of having had cancer and receiving aggressive therapy in the form of radiation or chemotherapy.

In addition, although the mortality rate is declining, cancer incidence is still increasing in children. Two types of cancer, leukemias and brain tumors, are the main drivers of the increase. SEER data on the average annual percentage change in incidence over time shows about a 1 percent annual increase in cancer incidence among children under the age of 14. The cumulative increase over 15 to 20 years is therefore 15 to 20 percent.

Dr. Robison reviewed the common epidemiological methods described below to identify the causes of cancer.

- Descriptive studies involve collecting data related to age- or race-specific incidence.
- Ecological studies aim to correlate two or more pieces of information.
- Cross-sectional studies examine populations at one given point in time.
- Case control studies compare data for a series of cancer cases to a series of controls (that is, children who do not have cancer).
- Cohort studies are difficult among children because cancer is rare.
- Clinical trials are recommended for prevention strategies but not for examining cancer etiology.

Dr. Robison acknowledged that there are groups in the United States extremely active in conducting epidemiologic studies on childhood cancer. For example, the Children's Cancer Group is a cooperative clinical trials group funded by the National Cancer Institute. The group has conducted over 20 individual investigations of various childhood cancers over the last 15 years.

Dr. Robison explained that epidemiologists tend to think of windows of exposure such as pre-conception, *in utero*, and postnatal periods. Concerns associated with the preconception and *in utero* periods include the parents' occupational exposure, medical exposures, general household exposures, lifestyle, and viral infections. Concerns associated with the postnatal period include children's medical exposures, the general household environment, and infections.

There is a strong research focus on childhood leukemia, which represents one of the most common childhood cancers. Leukemia is the most extensively studied childhood cancer from an epidemiologic standpoint, primarily because there exists a sufficiently large population to study in order to draw conclusions.

There are two primary kinds of childhood leukemia, acute lymphoblastic leukemia (ALL) and acute myloid leukemia (AML). ALL has a characteristic peak between 2 and 4 years of age. It occurs primarily in

industrialized countries, and the peak has been observed to occur as a country industrializes. White males have the highest ALL rates. Childhood leukemia rates have increased 1.5 percent per year over the last 20 years. AML is very rare among children; approximately 300 cases are diagnosed each year in the United States. Incidence rate is high during infancy, after which it decreases. The increase in the incidence of AML is lower than the increase in ALL.

AML represents a spectrum of diseases: morphologically, there are seven distinct types of AML, each associated with a different set of genetic abnormalities, different age distributions, and different responses to therapeutic approaches. In terms of risk factor, increased birth weight is associated with an increased risk of AML and ALL during the first 2 to 4 years of life. The risk increases for mothers over the age of 35 and is most pronounced in women over the age of 40. Rates of ALL or AML are higher among children whose mothers previously suffered miscarriages.

In terms of known or suspected factors associated with increased risk, Dr. Robison stated that parental smoking before conception is very controversial. Dr. Robison concludes that parental smoking is not a risk factor for offspring with childhood leukemia. He cited diagnostic X-ray exposure during pregnancy as being the only single factor consistently identified as a risk factor. Dr. Robison's research team has recently submitted a paper for publication suggesting that X-ray exposure *in utero* has reached a sufficiently low level in the United States and is no longer a detectable risk factor. In terms of postnatal exposure, radiation can cause leukemia. Studies of certain chemotherapy agents, solvents, and pesticides as potential risk factors have generated conflicting results.

A radon study recently completed by the University of Minnesota and the National Cancer Institute measured indoor radon levels in a case control study. The study showed no association between indoor radon levels and the incidence of childhood leukemia.

In closing, Dr. Robison stated that future research should focus on improved exposure assessment, including the need to identify what individuals have been exposed to and the contribution of genetic factors both in terms of genetic susceptibility and genetic markers of exposure and effect.

Dr. Leslie Robison is Associate Director of the University of Minnesota Cancer Center, where he was the recipient of the Endowed Chair in Pediatric Cancer. Dr. Robison is also Chair of the National Epidemiology and Cancer Control Strategy Group, which is a network of institutions and investigators responsible for treating approximately 50 percent of the childhood cancer cases in the United States.

Childhood Cancer
OVERVIEW/EPIDEMIOLOGY
QUESTIONS AND ANSWERS

Childhood Cancer Mortality

Ms. Michele Palmer (EPA Air Program and Department of Health and Human Services) asked Dr. Robison for the total childhood cancer mortality rate in the United States.

Dr. Robison replied that, with approximately 7,000 children being diagnosed with cancer each year and the current mortality rate being about 30 percent, between 2,000 to 2,500 children die annually in the United States from cancer.

Disease Clusters

Ms. Beth Fiore (Wisconsin Division of Health) asked Dr. Robison what the likelihood is that leukemia clusters, which involve a variety of different types of ALL or AML, share a common etiology.

Dr. Robison stated that he has been involved in several studies of cancer clusters and that in such studies, researchers strive to find a common denominator. However, when a cluster is found to include a combination of ALL and AML, researchers become suspicious. More recently, his research team examined the phenotype of various types of cancers. Epidemiologic data today now include state-of-the-art phenotypic characterizations of cancers. Based on such data, a common aggregation of risk factors within any given phenotypic group cannot be identified. For this reason, his group does not tend to consider whether a t-cell ALL or a null-cell ALL is involved; however, the group usually looks for distinctions between ALL and AML. Typically, researchers are concerned with a combination of leukemias, especially if the leukemias are all AMLs because AML is a higher target leukemia for the environment based on existing data. Dr. Robison stated that he is not highly concerned about clustering if a mixture of leukemias is involved.

Childhood Cancer

NATIONAL CHILDREN'S ENVIRONMENTAL CANCER REGISTRY

Dr. Je Anne Burg

ATSDR

Dr. Je Anne Burg's presentation focused on the feasibility of a National Environmental Childhood Cancer Registry. Prior to discussing the children's registry, Dr. Burg discussed ATSDR's current activities. Under Superfund legislation, ATSDR was mandated to establish a registry of persons exposed to toxic substances and a registry of persons with diseases possibly resulting from exposure to toxic substances. ATSDR has compiled a chemical-specific subregistry consisting of TCE, benzene, trichloroethane (TCA), dioxin, chromium, and iodine $(I)^{131}$. The TCE subregistry consists of approximately 5,000 people who reside near waste sites and have documented exposure to TCE. The baseline for the subregistry was started in 1989, and ATSDR has followed individuals in the subregistry ever since. ATSDR collects general health information on these people, compares the information to national norms, determines if there is an excess of a health condition, and if so, conducts follow-up work.

ATSDR is completing a speech and hearing study on the TCE group, and the results will be published in August 1998. ATSDR is also completing a reproductive study that examines the birth weights of children whose mothers gave birth during exposure to TCE and other contaminants. In addition, ATSDR is tracking excess cancer, diabetes, and anemia cases in women and children.

Other ATSDR registries include a benzene registry in Tomball, Texas, which contains information on 1,500 people; a TCA registry in Vestal, New York, on 3,500 people; and a dioxin registry in Times Beach, Missouri, on 250 people. The registries are very heavily endorsed by the general population, as shown by the 95 to 100 percent response rate among those invited to become part of the registries. In addition, participants are staying involved. The ATSDR databases, publications, and technical reports will be put on the Internet before January 1, 1999.

A new initiative of the registry concept is to create a National Environmental Childhood Cancer Registry. So far, consensus cannot be reached on how to define the term "environmental" in terms of this registry. Although the idea of a childhood cancer registry is not a new one. The current emphasis on establishing such a registry was prompted by President Clinton's task force on environmental health and safety risks to children, which established the Cancer Work Group. The Cancer Work Group has identified five initiatives, one of which is a childhood cancer registry, to aid in answering questions related to childhood cancer. A planning committee has been formed to explore issues such as what the registry should include. The National

Childhood Cancer Registry Planning Committee includes Malcolm Smith (National Cancer Institute [NCI]), Je Anne Burg (ATSDR), Rebecca Calderon (EPA), Dale Sandler (NIEHS), Tom Sinks (CDPC), and Brooke Steele (CDPC).

The goal of the project is to create a national registry of children with cancer that includes environmental exposure information. The information could be used to assess the relationship of cancer occurrence and other factors such as environmental exposures. Obtaining registrants is the easy part; however, obtaining information on the exposure history and identifying variables for each registrant will be more difficult.

The committee first discussed who should be included in the childhood cancer registry. Data for people from the ages of 15 to 19 are minimal. As a result, the word "children" was defined by the committee as those below the age of 15. Three major sources of cancer data for children under 15 include (1) the SEER program, (2) the NCI Clinical Trials Cooperative Groups, and (3) the National Program of Cancer Registries sponsored by CDCP and the State Cancer Registries. Dr. Burg presented information on these three sources and how they can contribute to the childhood cancer registry program.

SEER data collection began in 1973. Prior environmental data was almost nonexistent. Approximately 120,000 new cases are added to the SEER registry each year. In 1990, 1.6 million cases were on file at SEER. Data are collected on only 14 percent of the nation, however. SEER covers five states (Connecticut, Hawaii, Iowa, New Mexico, and Utah) and six metropolitan areas (Detroit, Atlanta, Los Angeles, San Francisco/Oakland, San Jose/Monterey, and Seattle-Puget Sound). Although SEER contains good data, it may not provide a complete national picture. The database consists of information from death certificates and newly diagnosed cancer cases.

There are 11 NCI Clinical Trials Cooperative Groups, 4 of which are devoted to pediatric cancer. The two major pediatric cooperative groups are the Children's Cancer Group and the Pediatric Oncology Group. For children under 15 years of age, these two groups cover almost 94 percent of the cancer cases diagnosed. Case information actually comes from the 200 oncology centers that comprise the group. However, for people between the ages of 15 and 19, the two groups are thought to cover less than 21 percent of the cancer cases diagnosed.

In 1998, the federal government invested about $21 million to enhance state cancer registries. The enhancement program is conducted by CDCP. CDCP has assisted states in establishing a state-wide central cancer registry system, the National Program of Cancer Registries. These registries exist in 49 states, the

District of Columbia, and 3 territories. The status of the registries varies from state to state. Dr. Burg stated that it is not feasible to consider information from these registries as a total representation of cancer incidence in the country. The standards for data quality and format of the cancer registries follow those described by the North American Association of Central Cancer Registries and CDCP national standards for completeness, timeliness, and quality. Dr. Burg expressed optimism that these registries will eventually provide very valuable data on a national scale. There is a great deal of cooperation between the SEER effort and the National Program of Cancer Registries effort.

The type of information needed for the National Childhood Cancer Registry includes (1) demographic variables, medical history, and genetic factors; (2) environmental factors or voluntary (lifestyle) exposures, including smoking, diet, and drugs; (3) involuntary exposures (for example, in the community or workplace); and (4) information on chemicals of concern. EPA and ATSDR have compiled a chemicals priority list consisting of 275 substances. Of these 275, it was determined that there is enough information available for arsenic, cadmium, lead, and zinc. These four chemicals therefore do not require additional research. In terms of radiation, an I^{131} registry is being established in Hanford, Washington, consisting of people exposed as children in the 1940s. Research will focus on the impact of childhood exposure on adult health conditions. Ionizing, ultraviolet, and nonionizing radiation have been suggested as part of the etiology of childhood cancers.

Dr. Burg expressed the challenge of compiling environmental data to identify commonality in factors. The National Childhood Cancer Registry Planning Committee will spend the next year examining the feasibility of such an environmental childhood cancer registry and consider how the environmental data will be retrieved. Dr. Burg remarked that in her experience, parents are very responsive in providing information. In addition to government stakeholders, the committee will need the input of the states, parents, and all relevant special groups that identify the impact of environmental exposures. The committee will call each group to assess the feasibility of a childhood cancer registry.

Dr. Je Anne Burg is the Chief of the Exposure and Disease Registry Branch at ATSDR. Dr. Burg was formerly the chief statistician at the NIOSH.

Childhood Cancer
NATIONAL CHILDREN'S ENVIRONMENTAL CANCER REGISTRY
QUESTIONS AND ANSWERS

Contact Information

Ms. Louise Fabinski (ATSDR) asked Dr. Burg how she can be contacted.

Dr. Burg stated that she can be reached by telephone at (404) 639-6202 or by e-mail at jrb3@cdc.gov. Dr. Burg welcomes all questions, inputs, and suggestions.

Environmental Factors

Dr. Howard Ehrman (University of Illinois School of Public Health) asked about environmental factors, specifically regarding occupational exposure, where parents could bring contamination back to the home. Dr. Ehrman referred to a NIOSH Report to Congress dated September 1996, and asked if there has been any follow-up to it. Dr. Ehrman also asked about efforts to address exposure to environmental toxins in schools and preschools.

Dr. Burg stated that part of the database contains an occupational sector, and NIOSH is very much aware of the impact of occupational exposure on the health of the entire family. Dr. Burg emphasized that occupational exposure needs to be considered in any registry. Exposure in schools and preschools is not specifically in ATSDR's area; however, it is an issue that should be addressed in the registry considering the number of hours that children spend in school.

Broader Approach

Mr. Brett Hulsey (Sierra Club) stated that his organization is releasing a report titled "The Great Lakes States, America's New Cancer Alley." This report follows up on a study of 22,000 childhood leukemia deaths related to automobile plants, steel mills, airports, oil refineries, highways, power plants, and asphalt plants. Mr. Hulsey asked if ATSDR could broaden its approach by targeting its efforts on these polluters first because we already know that they are causing problems.

Dr. Burg stated that bits and pieces of information need to be pieced together first. Historically, it has been difficult to get a "full picture" because agencies have different bits of information. The TRI is an important source of this information.

Stakeholders

Ms. Mary Beth Doyle (Ecology Center of Ann Arbor) asked whether Dr. Burg's committee plans to work with other stakeholders, such as community and industry groups, in addition to members of academia and government agencies.

Dr. Burg answered affirmatively, stating that the committee recognizes the contributions of these other groups. These groups are the key to the success of the program. Dr. Burg stated that the committee had recently met with such representative groups in Washington, DC, to discuss the initiation of this effort. The committee plans keep the groups informed, either through organized meetings or one-to-one communications.

Childhood Asthma: Risk Factors and Intervention Programs

CHILDHOOD ASTHMA IN THE INNER CITY

Dr. Richard Evans III
Northwestern University Medical School

Dr. Richard Evans III stated that he would present asthma data from the National Health and Nutrition Examination Survey (NHANES), morbidity data from the National Hospital Discharge surveys, and mortality data from Vital Statistics, followed by a status report of the National Cooperative Inner City Asthma Study (NCICAS). The NCICAS examined asthma in eight inner cities in the United States

Asthma's prevalence has been increasing in the United States since 1980, especially among children under age 18. Data from NHANES, which surveyed 3- to 17-year-olds, show that asthma is primarily a problem among young males, especially blacks. Other data indicate a significant increase in hospitalization rates for children under the age of 5. At Children's Memorial Hospital in Chicago, Illinois, a steady increase in the number of children admitted for asthma has been observed. The continued increase in asthma hospitalizations is a good surrogate for severity. Approximately 40 percent of admitted child asthma patients are African American, 40 percent are Hispanic, and 20 percent are white.

In addition to the increase in asthma's prevalence and hospitalization rate, asthma mortality rates are increasing. The death rate from asthma has been increasing since the late 1970s in the United States. A few years ago, a study found "pockets" of mortality from asthma in New York City, New York; Maricopa County, Arizona; Cook County, Illinois; and Fresno County, California. The population of New York City and Cook County combined represents 6 to 8 percent of the 5- to 34-year-olds in the United States. Of the asthma deaths, however, 21 percent occurred in New York City and Cook County. Several common factors are associated with asthma deaths, including (1) lack of appreciation of the severity of the disease, (2) lack of patient understanding that asthma can cause death, (3) poor compliance with asthma management techniques, and (4) discontinuity of medical care. Fatal attacks commonly occur outside the hospital, often in patients who have started using their bronchial dilators inappropriately because they do not realize the severity of the disease and who have not started using appropriate therapy (such as steroids). These patients tend to over-use acute medicines and under-use chronic therapy medicines.

Another study revealed the relationship between inner city, poverty, and minority populations to asthma. The study examined two different neighborhoods in New York City: East Harlem (93 percent black or Hispanic) and Greenwich Village Soho (70 percent white). East Harlem had an asthma hospitalization rate of 115 patients out of 10,000; Greenwich Village had an asthma hospitalization rate of 7.2 patients out of 10,000.

The median income in East Harlem was less than $11,000, while in Greenwich Village Soho, it was more than $19,000. The study concludes that the asthma hospitalization rate is much higher for poor minorities living in the inner city.

The research results discussed above have caused Congress and the National Institute of Allergy and Infectious Diseases to request proposals for an analysis of risk factors in the American inner city. The resulting study, NCICAS, was conducted by numerous institutions. Dr. Evans was part of the study and stated that the study focus groups met for 1 year to design a protocol to examine risk factors related to asthma severity in poor inner city populations.

NCICAS subjects were recruited from inner city areas in which 30 percent of household incomes were below the federal poverty level in 1990. The subjects were children with asthma symptoms that manifested within 2 weeks prior to enrollment. Selected subjects had also been diagnosed with asthma from hospitalization or an emergency room visit or were taking at least two classes of medicine within the previous 6 months.

The study enrolled 1,528 children from the ages of 4 to 9 and lasted from November 1992 through October 1993. Four interviews were conducted with each subject, a baseline interview and follow-up interviews at 3, 6, and 9 months. The retention rate was very good; 95 percent of the subjects were still involved 9 months after they enrolled in the study.

The baseline interview questionnaire identified the following risk factor issues: (1) access to quality health care, (2) the environment in which the family lived, (3) psychological and social issues of the family, (4) intrinsic host factors such as premature delivery, and (5) adherence factors or factors that play a role in the patient's ability to comply with prescribed medications. The baseline interview was extensive and took several hours to complete. In addition, an asthma information quiz was given to the children and their parents to gauge their knowledge about asthma. Enrollees also completed an examination consisting of four questions about alcohol use in the home.

Based on information from the baseline interviews, one of the study focus groups revealed the importance of access to health care. The group found many barriers to accessing such care, including transportation, medical costs, and availability of specialty care. There was also evidence of poor quality care when physicians did not follow proper guidelines for asthma management, lacked respect for parents, or did not educate the parents and children about asthma. Dr. Evans speculated that as a result, parents tend to take their children to the emergency room during acute asthma episodes and not go to the physician at all in the

period between episodes. Most of the children were depending on beta-agonist medication. However, according to 1997-1998 guidelines for asthma management, inhaled steroids are preferred. These observations indicate inadequate health care.

Additional results of the baseline interviews indicate that of the 1,528 children surveyed, 25 percent had been in the neonatal intensive care unit when they were born. Fifty percent had a family history of asthma. The parents were knowledgeable about asthma; they scored an average of 84 percent. The children scored an average of 66 percent. The parents were very highly motivated to take care of their children with asthma, scoring an overall high of 7.3 out of 9.0. The research team gave the parents several problems to solve and found that some parents had difficulty solving problems.

NCICAS also examined the responsibility for care in 1,271 subjects. Of the children, 32 percent (25 percent of whom were 4- to 5-year-olds) said that they were responsible for over half of their asthma management duties. In fact, however, 62 percent of the children had two caregivers, and 26 percent had three or more caregivers (that is, care provided by other members of the family in addition to the mother and father). Family cohesion and support for children with asthma was very high. However, the caretakers were found to be living in high-stress environments. Examples of stressful life events included being a single parent (47 percent), difficulty finding a job (39 percent), separation from a partner (39 percent), difficulty finding housing (36 percent), worsened financial situation (32 percent), and family drug or alcohol problem (24 percent).

The researchers learned that a child's behavior and mental health are very important associated risk factors. Of the subjects, 35 percent were diagnosed with problems of clinical severity and 50 percent of the adults had problems with depression or psychosis.

During the home environment evaluation, 77 percent of the children had at least one positive allergen skin test response. Mold spore, cockroach, house dust mite, cat, rat, and dog were the most common positive skin tests in children. Fifty-seven percent of the families surveyed lived in apartments.

The team collected dust and nitrogen dioxide (NO_2) samples in 621 homes. The study found that 59 percent of the families reported smokers in the house, 39 percent of the caretakers themselves were smokers, and 10 percent were smoking in the house during sampling. Cigarette smoke exposure is another risk factor.

Of the homes with high levels of NO_2, 24 percent had gas stoves and other heaters and poor ventilation. There was also a relatively large number of subjects allergic to cockroaches. When all data were adjusted for the risk factors described, high exposure to cockroaches and a positive skin test response to the cockroach allergen were highly associated with hospitalization, emergency room visits, more symptomatic days, more nights of lost sleep, and more school days missed.

In conclusion, inner city asthma is a multifaceted disease. Its risk factors include, but are not limited to, access to health care, quality of health care, compliance, adherence to psychosocial stress, multiple caretakers, lack of nonemergency care, self-sufficiency of the caretaker, and the problem-solving skills of the caretaker.

Dr. Richard Evans III is the head of the Division of Allergy at Children's Memorial Hospital and Medical Center in Chicago. Dr. Evans also holds a joint appointment as professor of pediatrics and medicine at the Northwestern University Medical School. In addition, Dr. Evans is a consultant for the World Health Organization Allergic Disease Center, a member of the International Health Committee for the American Academy of Allergy Asthma and Immunology, and has served as the Chairman and Principal Investigator for the National Cooperative Inner City Asthma Study.

Response Rate

Ms. Beth Fiore (Wisconsin Division of Health) asked Dr. Evans to what he attributes the great success of the response rate among study subjects.

Dr. Evans stated that a company was hired to conduct the interviews. The company learned what time to call subjects for responses. He added that study subjects were recruited based on the ability to reach the subjects by telephone. The subjects had to have access to a nearby telephone, either within their homes or next door. In addition, the subjects were issued a $5 voucher per telephone call.

Pesticide Use

An unidentified audience member asked if the research team examined the relationship between residents having a lot of cockroaches in the house and pesticide use. The audience member also asked whether pesticide use could be a factor in asthma causation.

Dr. Evans stated that this issue had not yet been examined but would be in a new survey.

Minority versus Poverty

Ms. Sandra Thomas (Chicago Department of Public Health) asked how many minorities lived in the low-income areas studied. She also asked if any other areas in the study cities existed that may be defined as "low-income" but that may not have met the group's criteria of 30 percent poverty.

Dr. Evans stated that the NCICAS method of defining the study areas identified poverty regions within the areas of recruitment that were manageable. He stated that poverty areas predominantly contained black and Hispanic populations. Dr. Evans added that minority families themselves also have a genetic tendency toward asthma. He reported that asthma among Hispanic populations outside of poverty areas (for example, in rural areas) was also common. He emphasized that he was not describing a minority issue but a poverty issue.

Diet

Ms. Tina Stevenson (Children's Memorial Hospital) asked Dr. Evans if diet had been considered in the study.

Dr. Evans responded that although it had been discussed, diet was not considered.

Cat Antigens and Pesticides

Dr. Victoria Persky (University of Illinois Chicago) stated that she had been conducting studies similar to the one that Dr. Evans described in terms of high cockroach antigen in the inner city of Chicago. Her study found many homes with high amounts of cat antigens that did not have cats. Regarding the pesticide issue, Dr. Persky cited a study that examined agricultural workers and asthma. The study found a very high ratio of asthma in agricultural workers in areas of organophosphate pesticides use. Dr. Persky stated that this finding could have major ramifications all over the world where pesticides (not only indoor application) may be related to asthma.

Microbial Contaminants

Mr. René Salazar (University of South Florida College of Public Health in Tampa) asked if NCICAS had examined microbial contaminants in the indoor environment.

Dr. Evans responded that no one expected the alternative skin test results to be quite as positive as they were. He reported that the new inner city asthma study will very carefully examine the indoor environment, specifically to quantify *alternaria* and two other molds in the home. He mentioned that Dr. Persky's study of post-flood asthma effects suggests that the relationship between microbial contaminants and asthma is very fertile ground for research.

Childhood Asthma: Risk Factors and Intervention Programs

PEDIATRIC ASTHMA: EPIDEMIOLOGY AND SUGGESTIONS FOR PREVENTION

Dr. Ruth Etzel
Food and Drug Administration

Dr. Ruth Etzel began by discussing how asthma detection methods that an individual physician might use with an individual patient can be applied to whole communities. She stated that communities have a major role in identifying specific factors for asthma prevention. Dr. Etzel reviewed several basic questions that a physician should ask an asthma patient, such as where the patient was when the attack began and when the attack occurred. These questions are asked to identify triggers that may have caused the attack. The same approach can be applied to communities to identify community factors and community-specific preventive efforts.

One of the most famous epidemics of asthma occurred in the 1950s in New Orleans. In 1955, more than 350 patients with asthma were treated at the Charity Hospital emergency room in New Orleans in a period of less than 24 hours. During that period, two patients died. In November 1960, over 200 persons with asthma sought care at the same hospital in a single day. Epidemics like this continued in New Orleans in 1964, 1966, and until 1968, when the epidemics suddenly stopped. Doctors have spent many years trying to determine what caused these outbursts.

In 1928, about 200 cases of asthma were reported in Toledo, Ohio. Most asthma patients lived within 1 mile of a castor bean mill. A map of the neighborhood was prepared, including the mill and the distribution of the asthma patients' homes. Many of the patients had told the health department that their attacks coincided with an odor from the mill when the wind blew in their direction. The health department concluded that the outbreaks were caused by inhalation of castor bean grinding dust. The asthma epidemic ceased after the factory stopped processing castor beans. This outbreak demonstrated very clearly to the public health department that space-time clusters of asthma can be used to identify preventable asthma causes.

Barcelona, Spain, was plagued for many years by asthma epidemics. The clinicians in Barcelona documented 26 asthma outbreaks between 1981 and 1987. During these epidemics, 687 people were affected; 20 died; and 1,155 were admitted to emergency rooms for asthma treatment. The largest number of patients came to the emergency room between 11 a.m. and 1 p.m. Typically, asthma admissions occur late at night, not in the middle of day. A map was prepared to track where patients were located when the asthma attacks occurred. The largest number of patients had been at Barcelona's very busy harbor. The public health department determined that soybeans from ships in the harbor were being unloaded every single day of the epidemic. The

soybeans were vacuumed from ships into trains, thereby generating dust. The public health department concluded that the outbreaks of asthma in Barcelona were caused by the inhalation of soybean dust released during the unloading of soybeans. Once bag filters were placed on the top of the silos to prevent the release of soybean dust into the air, the asthma epidemic completely stopped.

The findings in Barcelona led United States epidemiologists to re-examine the asthma epidemics in New Orleans. They found that 90 percent of the grains produced on Midwest farms is shipped out from New Orleans' harbor. There are more than 60 grain loading facilities on the Mississippi River from Baton Rouge to New Orleans, including one within 1 mile of Charity Hospital. The public health department reviewed old shipping records and determined that the asthma epidemics occurred when soybeans were unloaded at the harbor. Soybean dust was again the cause of the asthma epidemics. The New Orleans epidemic seemingly disappeared on its own because industrial hygiene developed in the late 1960s caused filters to be attached to silos, thus mysteriously ending the epidemic.

Soybeans and castor beans are well established as causes of asthma outbreaks. Such outbreaks teach us about asthma prevention and modifiable point source exposures. Epidemiological studies may help answer some of the puzzling questions about asthma in children. For example, the reason for an increase in asthma is not fully understood. The prevalence of asthma in children ranges from 0 percent in the Eskimos of Northern Canada and Alaska to a high of 17 percent on the island of New Zealand. Several studies have shown that the incidence of asthma and allergies tends to rise in countries where childhood immunization rates are high. These results have prompted epidemiologists to speculate whether certain infections may trigger immune changes that somehow protect children from developing asthma.

Preliminary studies show a protective effect from measles infection and infections with intestinal parasites. For example, a study in Guinea-Bissau, West Africa, showed that a history of childhood measles infection at the time of an epidemic was associated with a more than 50 percent decrease in the rate of positive atopic skin test results 14 years later. Childhood measles vaccination was not associated with any reduction in allergies or asthma. In a Japanese study that examined 900 children, those who tested positive for tuberculosis (TB) were only one-third to one-half as likely to exhibit asthma symptoms as those who tested negative. Some researchers have speculated that the decline in childhood TB infection in Japan is linked to the recent asthma epidemic. It is possible that because TB triggers a delayed hypersensitivity reaction, a vaccine designed to elicit this reaction might prove effective in fighting allergies and asthma in children.

However, not all evidence supports this hypothesis; in fact, much evidence refutes it. A recent Swedish study showed that early BCG vaccination in children with an atopic heredity did not seem to affect the development of atopic disease before school age. However, the incidence of TB is about 10 times higher in Japan than in Sweden. The Japanese children who contracted a real TB infection had a lower rate of atopic disease. Swedish children that had the BCG vaccination but no real infection did not appear to have a lower rate of atopic disease. Real infection but not vaccination seems to have some protective effect against allergies and asthma. Dr. Etzel commented that studies are needed to investigate the effects of natural infection versus immunization on preventing atopy.

Some suggest that pediatricians examine a potential vaccine strategy against asthma for children. The feature distinguishing the allergen-responder status of atopic children from that of nonatopic children is the nature of the T-cell subsets that dominate in their systems. T-helper 1 (T_{H1}) cells dominate in normal children, and T-helper 2 (T_{H2}) cells dominate in children with asthma and allergies. Some researchers speculate that a set of specific infections that strongly promote T_{H1} immunity could inhibit atopic disorders by repressing T_{H2}. A vaccine designed to elicit a delayed hypersensitivity reaction might therefore prove effective in fighting asthma in children. Dr. Etzel proposed that vaccination with a cocktail of the major inhalant allergens at the appropriate time in childhood may provide a safe and reliable method to bolster populations of the desired T_{H1} cells.

Asthma epidemics usually occur in short space-time clusters. These space-time clusters of asthma attacks may suggest modifiable point-source exposures. Public health workers need to be alerted about abrupt increases in the number of patients needing acute care for asthma because such situations present ideal opportunities for studying asthma prevention.

In 1997, the National Institute of Health (NIH) released new "Guidelines for the Diagnosis for Management of Asthma." The guidelines specify questions to ask individual patients related to the environment. In addition, there are five allergens in indoor air that physicians should question their patients about: animal dander, housedust mites, cockroaches, indoor molds, and tobacco smoke. The NIH guidelines also specify ways to reduce the presence of these allergens.

One of PHS's objectives for the Year 2000 is to reduce asthma among blacks and other nonwhites to a target of 265 hospitalizations per 100,000 people. Furthermore, PHS would like to reduce asthma hospitalizations among children less than 14 years old to 225 per 100,000 people. Dr. Etzel stated that these goals are currently very difficult to attain. She asked the audience to help in determining ways to prevent

environmental factors from contributing to asthma hospitalizations of children so that PHS's Year 2000 objectives can be achieved.

Dr. Ruth Etzel is the Director of the Division of Epidemiology and Risk Assessment at the Office of Public Health and Science of the Food and Drug Administration. Among her many professional activities, Dr. Etzel is the Chair of the Committee on Environmental Health for the American Academy of Pediatrics. She will also be the Editor of the "Handbook of Environmental Health for Children," which is scheduled for publication in the near future.

Effect of Obesity

Mr. Jonathon Ramlow (Dow Chemical Company) asked for Dr. Etzel's opinion on the association between childhood obesity and childhood asthma in light of the current trends in obesity among United States children.

Dr. Etzel commented that the hypothesis that the two are related is fascinating and felt that it was worth studying. She agreed that the hypothesis had some biological plausibility and that trends indicate a possible connection.

Immunization and Asthma

Ms. Bonnie Salazar (University of South Florida School of Public Health) asked that if the asthma rate increase corresponds to the immunization rate increase, would asthma rate also increase in populations that have higher immunization rates. Ms. Salazar commented that this idea contradicts the finding that low-income individuals and minorities who may not have easy access to immunization suffer from higher asthma rates.

Dr. Etzel responded that studies conducted so far did not examine population groups within a country; instead, they are simply ecologic analyses of entire countries. She acknowledged that the idea that high immunization rate corresponds to increased asthma rate could fall apart upon examination of individual groups having less access to childhood immunization. Dr. Etzel stated that clearly, there is a lot of work to be done and added that findings from whole broad-based ecologic analyses may not be necessarily true for studies of subsets.

Dust versus Particle Size

Regarding the soybean and castor oil hypothesis, Dr. Howard Ehrman (University of Illinois Chicago) asked if dust from the beans versus particle size had been examined.

Dr. Etzel stated that the effects were ultimately attributable to the actual soy protein. This hypothesis was supported by a case-control study involving the analysis of blood samples specifically for soy proteins.

Effect of Vaccinations

Dr. Victoria Persky (University of Illinois Chicago) asked if studies had been conducted that examine the timing or multiplicity of vaccinations in relation to asthma.

Dr. Etzel commented that all data she found were from Japan or Europe. She was not aware of any United States studies that examined timing or multiplicity.

Indoor Allergens

Mr. Rene Salazar (University of South Florida College of Public Health) asked Dr. Etzel about the effectiveness of some aggressive strategies, for example, the use of neutralization substances, to reduce levels of cat or dog allergens.

Dr. Etzel stated that it was difficult to determine the effectiveness of such individual strategies because in studies, investigators usually applied several different intervention techniques at one time in one population. Dr. Etzel commented that the effectiveness of each individual strategy could be determined if the intervention techniques had been administered sequentially.

Mr. Salazar then asked Dr. Etzel if *Cladosporium* and *Alternaria* were studied more often than other microbial contaminants in indoor environments because they are easily tested for.

Dr. Etzel agreed that *Cladosporium* and *Alternaria* are easier to test for. However, most researchers agree that it is necessary to examine the effects of other organisms.

The Effect of Industrial Areas

Ms. Sharon Ellis (Claretian Medical Center) asked if Dr. Etzel had examined the effect of industrial areas on asthma incidence.

Dr. Etzel responded that many ambient air pollutants have been studied as possible triggers of asthma in children. She acknowledged that it is quite plausible that industries could be causing asthma in children. Dr. Etzel added that it is also possible that a high level of particulates or ozone characteristic of such areas can cause asthma. Industrial conditions are a valid community consideration.

Childhood Asthma: Risk Factors and Intervention Programs

COMMUNITY-BASED ASTHMA EDUCATION AND CASE MANAGEMENT: REACHING THE UNDERSERVED

Ms. Claudia Baier
Rush Medical College

Ms. Claudia Baier began by defining some of the problems in treating the underserved. Two recent studies have been conducted of people considered underserved by the public health care system. Results indicate that (1) clients perceived the health care system as insensitive to their needs and their knowledge level and (2) providers did not teach clients asthma management techniques. Many clients in one of the studies viewed asthma as an episodic event that did not require ongoing treatment. Underserved patients also felt that there was not much more to learn about the illness or asthma management. These studies indicate that health care providers are not listening to their patients and are not teaching patients what they need to know regarding asthma management.

Ms. Baier presented four intervention techniques that have been applied to underserved populations: nursing outreach, health care personnel training, the use of the community health worker (CHW), and community-based partnerships to promote intervention. To implement nursing outreach intervention, nurses conducted specialized education with their asthma clients and at times followed up with telephone calls or home visits. For example, in Boston, Harvard Community Health Plan nurses conducted individualized education with their clients and follow-up telephone calls after clinic visits for up to 2 years, as needed. As a result, asthma hospitalizations and emergency room admissions significantly decreased.

The goal of health care personnel training was to help such personnel better deal with the underserved. Columbia University staff in New York worked with 22 New York City Bureau of Health clinics. The Columbia University staff trained all employees in 11 of the clinics and left the other 11 clinics as controls. Over a 2-year period, there was a significant increase in the trained staff's ability to identify new cases of children with asthma, provide continuity of care with their clients, and provide appropriate care based on the medications prescribed.

CHW intervention involves recruiting people outside the traditional medical setting to reach underserved people. Johns Hopkins University in Baltimore conducted a 5-month intervention in two cities. In two of the four intervention groups, they used CHWs. CHWs were able to gain access into the patient homes, locate families, obtain information, and provide basic asthma education. Another study showed that use of CHWs decreased asthma-related emergency room visits, hospitalizations, and unscheduled visits.

Community-based intervention is established within and planned in partnership with the community. It is designed to reach the general population in need and have broader capabilities than the other three types of interventions discussed above. The responsibility for implementing the intervention program is shared by the community and health care organizations as partners. For example, the University of California, Los Angeles conducted a 4-year pilot program in Latino communities using a family-centered education advocacy approach. The community as a whole developed an awareness of asthma. In addition, hospitalizations, emergency room visits, and acute care visits decreased among the families involved.

Ms. Baier then introduced the Henry Horner-Westhaven Pediatric Asthma Program, a partnership between the Westhaven Community and Rush-Presbyterian-St. Luke's Medical Center (Rush). Established in 1994, this community-based partnership is being conducted in Chicago. The sponsors of the program are the Northern Trust Company and the Chicago Housing Authority (CHA).

Ms. Baier presented 1997 data on the Henry Horner Homes, an apartment-based community with a population of 2,158 in 682 households. Eighty-eight percent of these homes have females as the head of the household. Forty-nine percent of the residents are under 15 years old. Twenty percent of the households are employed, and $8,900 is the average household income. Ms. Baier described the Henry Horner Homes as a community having problems with waste management, pests, dust, and noise. Building conditions vary depending on the management company.

The goals of the program are to (1) reduce morbidity and mortality from asthma among 2- to 12-year-old children who live in the Henry Horner-Westhaven community through learned self-help behavior; (2) provide asthma education and case management services to families who have asthmatic children; (3) employ residents from the neighborhood as community asthma workers (CAWs); (4) link families with asthmatic children to health care and social service networks and resources; and (5) develop a successful and replicable model for academic health centers and community partnerships.

The idea of the program was conceived in 1993, when several Rush students were tutoring children in the Henry Horner Homes. Some of the parents and community leaders approached the students for help with the problem of childhood asthma. These people worked with Ms. Baier and her team to help develop the program model and plan and implement the program. CAW training involved several steps, specifically, training community members about the following: (1) program goals, job descriptions, role of the health professional, and the community-based case management-team approach; (2) respiratory system anatomy and function; and (3) asthma and allergy management. In addition, CAWs formed partnerships with families

through home visits, by setting goals, and by encouraging communication, advocacy, conflict resolution, confidentiality, referrals, and recruitment. CAW responsibilities included home visits, asthma education, case management and referrals, involvement in support groups assisted by students, program organization, community outreach, and fostering teaching and awareness by conducting conference and classroom presentations in nursing and medical colleges.

Ms. Baier described that upon enrollment, participants in the program are asked about their health history. The CAWs begin with weekly visits. As participants begin meeting "graduation criteria," CAWs visit every 2 weeks, every month, and then every 2 months.

Ms. Baier presented a case study of a 7-year-old boy who lived with his single, unemployed mother. The boy, Jeffery, had a regular provider whom he was to see every 2 weeks. He also belonged to an HMO. Because of transportation problems, it was difficult for Jeffery's mother to take him to the physician a few miles away. Jeffery had very severe asthma and was on five medications. When Jeffery was not at school, he was kept in his room, the cleanest place in the home. The family also needed clothing and food. After 2 years of weekly CAW visits, the program was able to teach Jeffery and his mother about his asthma triggers, symptoms, medications, and how to use a peak flow meter to indicate when he might need to use his medication. They also received a management plan from his doctor. Because Jeffery learned how to take care of himself, it relieved his mother of some stress, and they worked as a team to manage his health care.

Over the first 2 years of the program's existence from 1994 to 1996, 48 children from 4 to 11 years of age from 45 families were enrolled. The children were mostly boys who had moderate to severe cases of asthma. Upon enrollment, 77 percent of families were able to identify one or more health care provider, and 82 percent received Medicaid. Health care problems consistently identified by families included problems with medication or equipment, health care coverage, accessing care and scheduling appointments, and getting along with their health care providers. The CAWs identified other family problems such as other children who were sick in the home and limits on daily health care activities because of violence, drugs, smoking, food and clothing acquisition, overcrowded conditions, and lack of communication with schools.

Ms. Baier reviewed specific outcomes and benefits to participants, CAWs, and health profession students. In addition to positive social outcomes, there are also positive health trends. Asthma exacerbations, clinic appointments, emergency room visits, and hospitalizations have decreased in the patients involved in the Henry Horner-Westhaven Pediatric Asthma Program. Benefits to CAWs include training and employment, reputation as patient and community advocates, networking opportunities, and increased self-esteem. Health

profession students benefit by understanding asthma as a public health concern and a primary care illness; gaining experience not available in a traditional, hospital-based educational setting; learning about health and illness from a community-based perspective; and understanding the complexities of health care outside an academic health center.

Ms. Baier discussed successes related to the feasibility of the program and the development of the program model. The program has been maintained continuously since 1994. The average length of participation in program is 14.5 months. However, the program observed an attrition rate of 40 percent. Of the 2,000 scheduled home visits, 82 percent were kept. Other successes include acceptance by the community, requests from other communities for the program, assistance during planning and implementation meetings, frequent referrals, requests for information and presentations, CAW representation on committees, and donation of resources and space.

In summary, Ms. Baier stated that she believed the CAW model is successful in reaching underserved families and improving asthma management. In addition, the success of the program shows that a trusting and effective partnership can be sustained between a community, an academic health center, and other parties.

Ms. Claudia Baier is an assistant professor of Preventive Medicine at Rush Medical College, which is part of the Rush-Presbyterian-St. Luke's Medical Center in Chicago. Ms. Baier serves as Director of the Rush Community Service Initiatives Program, which provides health profession students opportunities to perform community outreach. As part of this effort, Ms. Baier and her colleagues have developed a community-based asthma intervention program.

Cost of Program

Mr. Les Smith (ATSDR) asked if any costs could be provided to allow others to determine the feasibility of implementing similar programs elsewhere.

Ms. Baier responded that the program is currently being run on a "shoestring" budget. Before the recent welfare-to-work legislation was passed, the budget was sufficient. The biggest cost is paying CAWs. Ms. Baier reported that the program is currently seeking increased funding. Unless CAWs receive a salary and health care benefits for their families, the sustainability of this program would be difficult. Costs would depend on the specific kinds of intervention involved and staff needs.

Dr. Victoria Persky (University of Illinois Chicago) stated that the cost of community-based interventions is the key. She stated that her group is also vested in peer education and that costs are not insubstantial. She explained that her group is not just educating; it is also moving people from welfare to work. Dr. Persky stated that these programs, among others, can show more effective welfare-to-work results than many other job training programs as long as there is an appropriate infrastructure. She then stressed the need to account for the benefits of welfare-to-work, as well as the substantial cost and other gains in less missed school days, mothers being freed from worry about the children, mothers being freed to work, and decreased hospitalization and doctors' visits. She concluded by stating that although it is not cheap to implement such programs, the benefits are huge.

Expansion of Program

Ms. Sandra Thomas (Chicago Department of Public Health) asked whether there were ways to complement the program's clinical and specific-family oriented approach to asthma management with structural issues, such as lack of affordable transportation and lack of safe access to transportation in these communities. She felt that dealing with some of these issues would lead to longer term community benefits.

Ms. Baier agreed that public health workers have an advocacy role to promote change. She commented that a program like this meets immediate needs and, for the people, does create long-term change. Training of health care students is also important. Ms. Baier agreed that a lot more needs to be done.

Childhood Asthma: Risk Factors and Intervention Programs

ASTHMA AND AIR POLLUTANTS -
HEALTH EFFECTS AND ENVIRONMENTAL REGULATION

Dr. David McKee
EPA Research Triangle Park

Dr. David McKee discussed regulations related to air pollutants, EPA research of respiratory health effects in children, and whether EPA research findings are considered when EPA sets air pollutant standards. Based on Clean Air Act (CAA) requirements, in 1971, EPA established national ambient air quality (NAAQ) standards for criteria pollutants. In 1977, EPA revised the CAA to require a review of air standards every 5 years, and some of these standards have changed since 1971. For example, the photochemical oxidant standard is now an ozone or smog standard, and there is now a particulate matter (PM) standard of 2.5 microns.

The carbon monoxide (CO) problem has been almost completely resolved across the country. Very few nonattainment areas remain as a result of the implementation of inspection and maintenance programs and the use of catalytic converters in cars. The lead in the air problem has essentially been resolved because automobiles no longer use leaded gasoline. Similarly, the NO_2 problem has been resolved and no nonattainment areas remain; however, NO_2 is still part of the total emissions problem because it contributes to the ozone problem. Finally, the sulfur dioxide (SO_2) problem has been largely resolved through the use of low-sulfur fuels.

Different factors are considered to set and achieve NAAQ standards. To set the standards, only health and environmental effects are considered. During the implementation stage to achieve the standards, costs and time to attain the standards can be considered. The review process for NAAQ standards can take many years to complete. Fundamental information in the criteria document is obtained from thousands of peer-reviewed health studies. The criteria document is reviewed by the Clean Air Scientific Advisory Committee (CASAC) and the public. CASAC is an independent group of scientific advisors. Conclusions and recommendations from the staff are incorporated into a staff paper used by the EPA Administrator to develop a proposed decision on the standard. The staff paper is also reviewed by CASAC and the public. The proposed decision is then published in the Federal Register. In the most recent review of the ozone and PM standards, EPA received over 50,000 comments from industry and the public. The decision for ozone and PM standards was published in the Federal Register on July 18, 1998.

The scientific basis for revisions to the ozone primary standard was based on extensive review of thousands of scientific studies that highlighted over 180 key health effects studies. One of the studies dealt specifically

with the increase in childhood asthma in relation to higher ambient ozone levels in Atlanta. Such studies indicate that ozone levels below the previous standard (a 1-hour average of 0.12 part per million [ppm]) cause significant health effects in children and other susceptible groups. CASAC unanimously recommended that EPA replace the 1-hour standard with an 8-hour standard to protect against longer exposures that have now been clearly related to health effects at lower concentrations (at or below 0.08 ppm) and under more typical exposure conditions than under the 1-hour exposure scenario.

The ozone health effects of greatest concern include (1) moderate to large decreases in lung function, which result in difficulty in breathing and shortness of breath; (2) respiratory symptoms such as those associated with chronic bronchitis, aggravated and prolonged coughing, and chest pain; and (3) increased respiratory problems, such as aggravation of asthma and susceptibility to respiratory infection. In a study that will be published soon, it was determined that repeated exposures could result in chronic inflammation and irreversible structural changes in the lungs that can lead to premature aging of the lungs and other respiratory illness. A twofold increase in the rate of asthma onset was observed in areas where the ozone level was high for a period of time over areas with lower ozone levels.

Children who are active outdoors are at greatest risk from exposure to ozone. Children breathe 50 percent more air for their size than average adults, and their respiratory systems are not fully developed, making them more vulnerable to ozone effects. In addition, children have more respiratory and other illnesses, which puts them at higher risk. Asthma, the number one chronic disease for children, may be aggravated by ozone exposure. Children represent 25 percent of the United States population but 40 percent of the asthma cases. Children with asthma are a growing at-risk population, increasing by about 80 percent between 1982 and 1993.

It is anticipated that the new 8-hour ozone standard will result in approximately 500,000 fewer incidences of significant deficits in lung function and hundreds of thousands fewer incidences of moderate to severe respiratory symptoms per year. Individuals with asthma and other respiratory illnesses could experience fewer hospitalizations and fewer emergency room and doctor visits. For all at-risk populations, anticipated benefits include significant reductions in lung inflammation and possible irreversible structural changes that could lead to premature aging of the lungs and chronic respiratory illness.

Revisions to the PM standards were primarily based on an extensive review of thousands of scientific studies that highlighted over 80 key epidemiological studies. Over 60 epidemiological studies found significant links between PM levels at or below the previous standards and premature death or serious illness. Numerous

studies indicate that “fine” and “coarse” particles are fundamentally different pollutants. Fine particles are most closely associated with the increase in premature asthma deaths. Of 21 CASAC panel members, 19 recommend revising the PM 10 (coarse fraction PM) standards by adding standards for fine particles (that is, particles with diameters smaller than 2.5 microns, or PM 2.5). However, CASAC unanimously recommended retaining at least the annual PM 10 standard to continue to address health concerns associated with particles with diameters between 2.5 and 10 microns.

The health effects of concern associated with PM, especially the fine PM, include (1) increased premature deaths, primarily in the elderly and those with heart or lung disease; (2) aggravation of respiratory and cardiovascular illness in individuals with heart or lung disease and in children; (3) decreased lung function and symptomatic effects such as those associated with chronic bronchitis, particularly in children and individuals with asthma; (4) increased work loss days for adults and school absences for children; and (5) changes to lung structure and natural defense mechanisms in children and adults.

Coarse fraction PM standards have been retained and remain a health concern because coarse PM reaches sensitive areas of the lung. Coarse particles aggravate asthma and increase respiratory illness. Children are particularly sensitive to the adverse health effects of coarse fraction particles. Long-term build-up of these particles is also a concern.

The new and revised PM standards aim to increase the level of health protection. EPA projects tens of thousands fewer premature deaths per year, especially in the elderly and those with heart and lung disease. In addition, EPA anticipates thousands of fewer respiratory-related hospital admissions per year in children and adults and hundreds of thousands fewer incidences each year of aggravated asthma and respiratory symptoms in children and adults. The PM standards are expected to reduce tens of thousands of chronic bronchitis cases in children and adults annually and reduce the risk of childhood illnesses, which are of concern both in the short term as well as in relation to the future development of healthy lungs in affected children.

Other nationwide efforts are underway to reduce risks to children’s health. EPA is planning to reduce volatile organic compound (VOC) and nitrogen oxide (NO_x) emissions from industrial sources and vehicles and improve related inspection and maintenance programs. In addition, a federal advisory group of EPA, state agency, public interest group, and industry personnel has formed to identify ways to increase the efficiency and effectiveness of control programs for ozone and PM. Finally, states and EPA regional offices have been working together closely to increase public awareness through programs like Ozone Action Days.

In closing, the past is a success story. However, more needs to be done in the future, especially concerning ozone. The results will be reduced risks to children and reduced respiratory health problems.

Dr. David McKee is an environmental scientist in EPA's Office of Air Quality Planning and Standards at Research Triangle Park in North Carolina. Dr. McKee is recognized at EPA as a national expert on ambient air quality standards. He recently published a book entitled *Tropospheric Ozone: Human Health and Agricultural Impacts*.

Cost-Benefit Analysis

Ms. Michele Palmer (EPA Air Program) asked whether a cost-benefit analysis had been completed to examine the benefits of reduced hospitalizations and reduced lost days of work because of the new standards compared the cost to industries to implement new standards.

Dr. McKee stated that a cost-benefit analysis had been conducted when the new standards were proposed in 1997. The study shows that the benefits far outweigh the costs. However, many re-evaluations and reanalyses have since been conducted to consider new information. At least 24 studies published last year present new information to be considered. For example, several studies associate higher ambient ozone levels with increased risk of premature mortalities.

Chicago's Compliance Status

Ms. Palmer asked how Chicago rates in terms of compliance with the new ozone and PM standards.

Dr. McKee reported that a working group at the Office of Air Quality Planning and Standards is in the process of determining this issue. Dr. McKee anticipated that the group's decision will be announced at the end of the current year.

Ozone Action Days

Ms. Palmer asked whether it made any difference to stay indoors on Ozone Action Days even with the windows open or with a window air-conditioning unit.

Dr. McKee answered that ozone levels are lower indoors. Ozone is not produced indoors but as a result of the interaction of organic compounds, nitrogen, and sunlight. There is about a 90 percent reduction in ozone indoors than outdoors if a filtration system is used and windows are closed. Exercise levels should be reduced on high ozone days. Dr. McKee acknowledged the difficulty of getting children to stop being active but stressed the concern that high activity increases total ozone dose intake and causes ozone to penetrate the

lungs more deeply. The risk of inflammatory effects in lungs increases the deeper ozone penetrates into lungs. A problematic chain of events could begin, especially if the child is asthmatic.

Demolition Dust

Mr. Lionel Trepanier (Chicago Green Party) asked whether EPA had considered the risks to children posed by exposure to dust from demolition activities.

Dr. McKee stated that he thought demolition dust could be considered re-entrained dust. If so, then demolition dust has, to some extent, been considered in EPA's total exposure analysis for PM, ozone, and the other criteria pollutants.

Transportation

Dr. Howard Ehrman (University of Illinois Chicago) commented that the country is losing ground with regard to transportation. For example, sport utility vehicles are the predominant vehicles purchased in the United States in 1998. Another setback is the miles of track being built versus the number of vehicles per capita being built. Dr. Ehrman asked whether the EPA had discussed this issue with state and city agencies.

Dr. McKee stated that he felt that Chicago's rapid transit system was one of the best in the country and added that he had seen very few cities in the United States or Europe that could claim to have one as good. Dr. McKee believed that the excellent transit systems took many vehicles off the road.

Dr. Ehrman stated that in 1935, before the Chicago Transit Authority was established, Chicago had double the number of rails that exist today. Chicago is the only city in North America that has destroyed its rail system and stopped rail transportation after midnight and on weekends. Dr. Ehrman commented that Chicago has moved backwards. In addition, other cities that are building rail transportation are still losing the comparison of rail miles per capita versus the number of cars purchased.

Animal Feedlots

An environmental reporter from the *Star Tribune* in Minneapolis, Minnesota, asked whether anyone at EPA or in the audience had examined the respiratory health of children who lived near large animal feedlots.

Mr. Mario Mangino (EPA Region 5) stated that some of the states are working on this issue and that he would try to find the reporter some state contacts.

Politics

Ms. Maureen Headington (Board of Directors of Illinois Environmental Council) asked how susceptible Dr. McKee thinks the ozone and PM standards are to political pressures in Washington and how realistic it is to expect the standards to actually be implemented.

Dr. McKee responded that EPA is moving ahead at full speed to implement the State Implementation Plan (SIP) and control programs for the standards. He acknowledged that two external factors will continually play a role in the implementation process: the oversight responsibility of Congress and ongoing litigation between EPA and large industry groups. Congress will deliberate on the standards again this session, and Dr. McKee anticipates that a decision will be made toward the end of summer 1999. Regarding litigation with industry groups, Dr. McKee expressed confidence that the standards would hold up and that the program would be implemented.

Implementation of New Standards and the Urban Air Toxics Rule

Mr. Brett Hulsey (Sierra Club) asked when cities could expect to start seeing changes related to the new ozone and PM standards.

Dr. McKee stated that changes have already manifested with regard to public support and participation as exemplified by Ozone Action Days. EPA has also started modifying the Pollution Standard Index, which directs cities to alert the public about high ozone and PM levels. Dr. McKee projected that the SIPs would be finalized by the end of the current year and that much of the implementation program is expected to be place by then as well. Cities should begin seeing changes next year. Complete implementation of the new programs will take several years.

Developmental Effects of Environmental Contaminants
EMBRYOS, INFANTS, AND CHILDREN:
SUSCEPTIBLE POPULATIONS FOR ENDOCRINE DISRUPTION
Dr. Michael DeVito
EPA Research Triangle Park

Dr. Michael DeVito's presentation addressed developmental toxicity, specifically endocrine disrupters and their developmental effects. Existing test methods can generally identify chemicals that are clearly teratogens, for example, chemicals that cause cleft palate or gross malformations. However, current test methods do not reveal subtle developmental effects as readily, such as increase or decease in sperm count or early reproductive senescence. Dioxins are an example of chemicals that cause such subtle effects, which are primarily due to alterations in the endocrine system.

Dr. DeVito stressed the importance of understanding the differential sensitivity of embryos and children. Development is a highly integrated process that involves growth and differentiation. Major regulators of development are hormones and other growth factors. Exposure effects differ depending on when the organism is exposed during development.

Susceptibility is determined by exposure and inherent sensitivity of the organism. Indirect exposure of embryos and fetuses is determined by the mother's past and present exposure. Chemicals in the mother diffuse into the fetus. After birth, infants are indirectly exposed through mother's milk. At an older age, children, like adults, experience direct exposure through air, water, and food ingestion. However, children are more exposed to dust and dirt than adults and absorption may be much greater in infants.

The endocrine system consists of any glandular tissues or cells that release a hormone or chemical messenger that affects a target tissue or cells in order to produce a physiologic response. Disturbance of endocrine homeostasis can result in dire consequences or more subtle effects. One could observe metabolic derangements, developmental abnormalities, and reproductive dysfunction. Chemicals that disrupt homeostasis during development may result in reproductive, neurotoxicity, or immunotoxicity in the developing organism. In an endocrine system, a tissue releases a substance that travels to a distant target organ through the blood. A paracrine system releases a growth factor or hormone to nearby systems or cells. An autocrine is a same-cell component that produces a hormone or growth factor to augment the natural processes of that cell.

Most of these hormones and growth factors interact with receptors. For example, polypeptide hormones react with membrane-bound receptors. Androgens and estrogens are examples of intracellular receptors. There is only one ligand-activated receptor, the AH receptor, which is activated by dioxin-like chemicals.

Multiple hormonal systems interact. For example, if thyroid hormones increase, decreased sperm count results. Changes in sex steroids can affect pancreatic secretion of insulin. Stress, which causes an increase in glucocorticoids, interferes with insulin secretion. Affecting thyroid action in turn affects androgen function. Similarly, affecting sex steroid levels affects insulin and other growth hormones. Estrogens and antiestrogens can impact the immune system. Glucocorticoids can be immunosuppressive. Thyroid hormones are thought to play a role in many autoimmune diseases.

Hormonal pathways can be modulated in numerous ways. The synthesis, degradation, and transport of the hormones themselves can be affected; signal transduction can be altered; nuclear receptors can be affected by deoxyribonucleic acid (DNA) binding; and numerous systems can be altered by xenobiotics. Chemicals known to disrupt the system adversely affect the synthesis, degradation, or transport of these hormones. A significant challenge is to understand the effects of exposure to perchlorate or PCBs and other chemicals at the same time. Each chemical works at different sites and potentially interact.

Most tissues are target organs of one or more hormones. Most hormones have tier and feedback systems. A negative versus positive system modulates the feedback loops. The pulsatile or cyclical production of these hormones can also result in different effects. For example, male growth hormones are released in a pulsatile manner; in females, they are released at a low constant level. Multiple regulatory and counterregulatory feedback loops interact. The entire system is designed to maintain hormones at very specific levels.

Drugs can alter endocrine homeostasis and act as endocrine mimics to block endocrine action. A number of chemicals cause lesions in the adrenal gland, including adiamycin (a chemotherapeutic agent), chlordane, cadmium, kepone, and dioxin. These environmental chemicals can produce similar effects as pharmacological agents.

Although clear examples of endocrine disruption are observable in wildlife, human cases are harder to analyze. Many hypotheses exist, but data are limited. However, some pharmacological examples show that people respond to hormones in a very similar manner as animals.

The developmental reproductive toxicity of environmental estrogens evidenced by decreased sperm count, increased hypospadias, and testicular cancer. In women, there is evidence of increased breast cancer rates. Reported effects of exposure to environmental antiandrogens include decreased sperm counts, feminization of male behavior, and speculation of increased breast cancer in women. Thyroid perturbations in humans result in decreased sperm count, hearing, and intelligence. Thyroids are considered so important in development that all U.S. infants are screened for thyroid hormone levels before they leave the hospital. If low thyroid levels are detected, the child is put on thyroid replacement therapy within 2 weeks of birth. Thyroid hormones are very critical in development. Increased research is needed because of the number of commercially available chemicals that can affect thyroid hormone levels.

The best examples of endocrine disrupters are dioxins and PCBs, particularly in wildlife. Studies of domestic animals, laboratory animals, and humans indicate that these chemicals act as endocrine disrupters. Dioxins are a structurally related class of chemicals. Their effects are mediated by binding to the AH receptor, and they are persistent and bioaccumulative. Dioxins produce a common spectrum of responses. Dr. DeVito revealed that these chemicals are developmental, reproductive, immunological, and dermal toxicants. They cause multiple effects in multiple tissues in both sexes in many vertebrate species. They also produce molecular changes that result in biochemical alterations such as altered metabolism, which in turn produces cellular effects. Altered proliferation and differentiation may result in tissue and organ effects. Altered homeostasis could result in overt toxicity, leading to death.

Dioxins disturb almost every hormone system investigated. They affect estrogen and progesterone receptors, affect thyroid hormone metabolism, alter some thyroid hormone binding proteins, affect serum transport, and affect multiple growth factor systems. Dioxins alter gene expression and signal transduction and cause clear effects of enzyme induction and cancer in animals. In humans, dioxins alter glucose metabolism rates, leading to diabetes. Immune and hormonal alteration and developmental reproductive effects have been observed as a result of exposure to dioxin.

PCBs have 209 congeners. A majority of these cogeners have individual inherent toxicities and multiple overlapping structural classes. PCBs can interact additively, synergistically, and antagonistically with dioxins and other PCB congeners, making it difficult to predict the effects of these chemicals. It is rare to find dioxins without PCBs. Because of the multiple action mechanisms, it is difficult to accurately predict the toxicity of a PCB and dioxin mixture. PCB effects in people and animals are documented and include enzyme induction, porphyria, developmental and reproductive effects, and chloracne. Limited evidence also suggests carcinogenic effects related to PCB exposure. The greatest concern related to PCB and dioxin

effects are developmental alterations occurring in people at "high end" exposures. These people have a slightly higher than background level of exposure. However, these populations show decreased neuro-optimality, and there is evidence of alterations in their immune and hormone systems. As a result, they have decreased IQ, altered behavior, and decreased growth. The effects in children after prenatal exposure to dioxins and PCBs include small stature, low birth weight, ectodermal dysplasia, altered behavior, decreased cognitive skills, immune system alteration, hearing problems, and puberty problems.

It is unknown whether all of the effects shown to have been caused by exposure to dioxins and PCBs are due to endocrine disruption. Endocrine disruption as a mechanism of reproductive and developmental effects is a viable hypothesis that has yet to be proven. If endocrine disruption is occurring in the general population, it is probably not attributable to a single chemical or cause. The challenge is to understand the effect of exposure to multiple chemicals that act on different pathways of a developing system. The developing embryo and fetus are likely to be the most susceptible organism, both in terms of inherent susceptibility and exposure.

According to Dr. DeVito, the real question regarding endocrine disruption in humans is not whether it is occurring but is whether it is occurring in the general population because of environmental exposure to multiple chemicals at low levels. Another important question is not what is the effect of such exposure on the individual but rather what is its effect on the distribution of the population.

Dr. Michael DeVito is a toxicologist in the Pharmacokinetics Branch of the Experimental Toxicology Division of the National Health and Environmental Effects Research Laboratory at EPA Research Triangle Park. His research has focused on the developmental effects of endocrine disrupters, the development of physiologically based pharmacokinetic models, and the development of models to predict the potential health effects of exposure to mixtures of chemicals.

Exogenous Hormones

Dr. Victoria Persky (University of Illinois Chicago) asked about the possibility of endocrine disruption caused by exogenous hormones used inadvertently during pregnancy, such as birth control pills.

Dr. DeVito agreed that all forms of exposure must be considered in any discussion about a developing child. Anyone taking such hormones during pregnancy should be well advised.

Dr. Persky asked if Dr. DeVito knew of any studies that examined the possibility that the decline in sperm count may be attributable to trends in exogenous hormones rather than trends in PCB or dioxin accumulation.

Dr. DeVito responded that for every study that showed a decrease in sperm count from PCB or dioxin exposure, he can find a study that concludes that there are no effects from such exposure. Effects appear to be regional. Early data came from Asian countries, followed by data in the 1970s from the United States and Europe. Some researchers in France observed a decrease in sperm count in some cities but not in others. Despite contradicting studies, Dr. DeVito stated that birth control pills are a concern. He agreed that such pharmaceutical agents must be considered in the research.

Antiandrogen versus Estrogen-Like Effects

Dr. Christopher DeRosa (ATSDR) asked whether a distinction can be made between antiandrogens and estrogen-like effects.

Dr. DeVito responded that although their responses are phenotypically similar, the two do differ.

Multiple Chemical Effects

Ms. Naomi Nah (University of Michigan, Ann Arbor) referred to Dr. DeVito's discussion of multiple chemical effects at low doses. She asked if he considers the definition of "low doses" to be under the

regulated level and if so, if low doses of a chemical that combines with other chemicals also under regulated levels could cause endocrine disruption.

Dr. DeVito agreed that this possibility exists, although currently, no evidence supports it. He believed that this issue is a concern, especially when several chemicals may affect the same organ system.

Testing and Screening

Dr. Ed Kerfoot (BASF Corp.) asked whether Dr. DeVito was involved in developing testing and screening methods for endocrine disruptors.

Dr. DeVito responded that although he has not been involved in the process, he had chaired a workshop on screening chemicals that may affect thyroid hormones.

Paradigms

Ms. Lynn Katz Chary (University of Illinois Chicago) acknowledged that Dr. DeVito advised examining different paradigms rather than the traditional approach of examining means and standard deviations. She asked what these other paradigms are and requested literature that presents more information.

Dr. DeVito responded that he was not sure. He is attempting to devise a paradigm for PCBs and dioxins. He stated that he was inclined to develop a model that would explain the processes, but this approach would probably cost billions of dollars. Quantitative risk estimates need to focus on whole exposure rather than on the effects of individual chemicals. This approach would have to be balanced by the study of other exposures and comparative risks, such as the effects of phytoestrogens compared to those of hydroxy-PCBs. Developmental models must be developed to describe the toxic effects of concern.

Neuro-optimality

Ms. Pam Shubat (Minnesota Department of Health) asked for a clarification of Dr. DeVito's statement that PCBs decreased neuro-optimality. She also asked how neuro-optimality was measured.

Dr. DeVito stated that the phrase was taken from Dutch studies where PCB levels were measured in mothers and cord blood. Infant thyroid hormone levels, immune levels, and neuro-optimality were measured over

time. He described it as a behavioral test similar to the Brazelton test. Dr. DeVito assumed that the studies involved examination of developmental markers that could be observed in the infant.

Developmental Effects of Pesticides and Polychlorinated Biphenyls

OVERVIEW OF ISSUES RELATED TO PESTICIDE EXPOSURE

Mr. Jeffrey Dawson
EPA Headquarters

Mr. Jeffrey Dawson presented scientific issues related to pesticide exposure. The focus of the presentation was residential exposure, which is defined as any exposure to a compound that is not through dietary intake or drinking water. Residential exposure for children includes dermal exposure, such as playing on treated turf and hand-to-mouth activities.

Mr. Dawson stated that estimating residential exposures, particularly for infants and children, is a difficult challenge because they are multiroute and multipathway. Various chemicals are used in residential areas and researchers need to determine how children spend their time in the home, which activities or behaviors contribute to exposure, and the chemicals being used during those activities. Mr. Dawson stated that his team is examining thousands of commercial pesticide products and addressing them on a product-specific basis. EPA generally examines the specific active ingredients of a chemical and then all the end-use products that contain that chemical. Commercial products being examined include classic pesticides such as lawn and garden chemicals and household insecticides, antimicrobial materials such as cleaning products and swimming pool chemicals, and coatings and bathroom paints containing antifungal compounds. The pesticide label displays warnings appropriate to the toxicity of each individual product.

Mr. Dawson presented tools and basic concepts that EPA uses when determining residential exposures. He also presented research issues in industry and academia raised by the FQPA of 1996.

As a result of the FQPA, EPA has refined a series of standard operating procedures (SOP). The residential SOPs are default models used to calculate residential exposures. The SOPs include distinct use sites in a residential environment and address more than 40 exposure scenarios. For example, for a turf chemical, the SOP document reports on the average exposure of a person who applies the chemical and also describes the methods used to calculate exposures for those who contact the turf after the application (such as a child playing on the grass). The SOP document is currently being reviewed by Office of Pesticide Program scientists, after which it will be submitted to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Science Advisory Panel for review and guidance.

The Pesticide Handlers Exposure Database created in 1986 is a tool used to predict exposures of those who apply pesticides. EPA has adapted this tool to the residential SOPs to estimate exposures for pre-teen and teenage children applying pesticides.

FIFRA guidelines are another major source of information for review of pesticides and for measuring exposure to pesticides. For example, the new Series 875 document contains guidelines for conducting residential exposure studies. It addresses such issues as designing a study, selecting the specific site and products to use, and methodologies for examining dermal exposure. The *Exposure Factors Handbook* finalized in 1998 has been extensively peer-reviewed. This handbook addresses such parameters as activity factors, breathing rates, and dermal surface areas.

Transfer coefficients are used to estimate postapplication exposures—that is, any exposures that result from entering an environment that has been chemically treated. A surrogate relationship is involved that is specific to a mechanical activity, such as a child walking or crawling. Ambient concentrations are used to predict exposures when transfer coefficients are not available. Studies designed to measure generic transfer coefficients for various activities are very expensive. EPA's approach is to capture large quantities of ambient concentration data and apply them to transfer coefficients for specific activities such as eating treated turf. These scenarios are described in the residential SOPs.

Among the various issues that EPA and academia are currently addressing are the best method to quantify nondietary ingestion, the importance of evaluating surface area per event, and source replenishment. Examples of study design-driven issues include a hand press developed by EPA for which a specific pressure is applied and the level of dermal uptake is examined under certain time and duration conditions. Research is also being conducted to determine contact pressures and durations that should be used in various hand-to-mouth scenarios.

Mr. Dawson explained that generic or activity-specific transfer coefficients are used to calculate exposure. A coefficient is then compared with ambient concentration levels. The transferable residual amount is the amount of residue available for hand-to-mouth intake or dermal exposure. There are several methods of source characterization. One is use of the polyurethane foam (PUF) roller developed by EPA, which involves rolling a cylinder of PUF across a specific area (such as hardwood floors, linoleum, or countertops) to determine residue uptake; the uptake is then compared to the application rate.

There are several issues associated with examining ambient concentrations, including comparability and ruggedness, application method and distribution, biological basis (to have a basis to correlate methods with actual doses), and sink effects and replenishment (a chronic exposure issue related to how pesticides are redistributed in the residence over time).

The human exposure monitoring techniques used at EPA are fairly standardized. Passive or whole-body dosimetry, which was developed by the World Health Organization, is based on using long underwear to simulate skin. The deposition on the garment is measured and used in exposure estimates. Another historical method is the dermal patch, which is placed on the body during certain activities. There is also the hand exposure method, which involves using gloves or hand rinses. Hand wiping is used to look at deposition to skin.

Activity pattern research issues involve developing a model to accurately predict exposures for various populations of interest. The model would identify how children spend their time and the activities they participate in that contribute to pesticide exposure. Direct observation and videotaping of a child playing at a daycare center are common methods used. Other issues of importance are consistency and use of a reference population in risk assessments and limited literature on hand- and object-to-mouth events.

Looking to the future, Mr. Dawson predicted progress related to implementing the FQPA. EPA is reviewing methods for calculating cumulative risks and aggregate risks. Mr. Dawson stressed the need for more distributional data related to actual product use and more distributional activity pattern data. EPA is heavily involved with the State of California, the European community, and Canada in harmonizing documentation. For example, in 1995, EPA issued a data call-in for turf chemicals; that prompted the formation of a large industry task force focusing on turf chemicals. In addition, issuance of EPA's residential SOPs has prompted significant research efforts related to the indoor exposure issues in academia, EPA, and industry.

Mr. Jeffrey Dawson is a chemist in the Health Effects Division of the Office of Pesticide Programs of EPA. Mr. Dawson has authored several guidelines and SOPs, coordinated residential research issues in response to the FQPA, and conducted pesticide exposure studies under FIFRA. Mr. Dawson is also working on standardizing pesticide regulations internationally.

Baseline Data

Ms. Pam Shubat (Minnesota Department of Health) asked what EPA is doing to provide a baseline or starting point for what children are currently being exposed to.

Mr. Dawson responded that EPA would like to review available data from biomonitoring of populations. He cited the National Human Exposure Assessment Surveys as a source for biological monitoring data along with the Agricultural Health Study available through the National Cancer Institutes, NIEHS, and EPA. It is definitely an objective to calibrate the predictive models using this type of data. Some of the industry and academic efforts are designed to couple the developing data with similar biological monitoring data for comparison to the predicted exposure estimates.

Accountability of Companies and Lead Levels

Mr. Abbas Hassain (Reduce Recidivism by Industrial Development, Inc.) asked where EPA stands on accountability for companies that had left pesticides and other chemicals within certain targeted communities.

Mr. Dawson stated that EPA has an enforcement arm to deal with accountability issues, and he hesitated to comment further without knowing the specifics of the situation.

Dogs

Ms. Linda Slobodnik (Northeastern Illinois University) asked about the effect of pet care products on dogs and the residual exposure to children.

Mr. Dawson stated that this was actually an area that was being addressed in one of the scenarios in the residential SOPs, and he cited EPA-sponsored research at the University of Mississippi. Exposure through pets, and specifically pet care products, is incorporated into risk assessments.

Developmental Effects of Pesticides and Polychlorinated Biphenyls

HOUSEHOLD USE OF METHYL PARATHION - THE CHICAGO EXPERIENCE

Dr. Anne Krantz
Cook County Hospital

Dr. Anne Krantz presented a recent case where Chicago residents were exposed to the toxic pesticide methyl parathion (MP).

MP is an organophosphate pesticide. Organophosphate pesticides are used widely in agriculture and occasionally in homes. They have limited environmental persistence but have a high potential for toxicity. Organophosphates exert toxicity by interfering with the activity of the enzyme cholinesterase. Acetocholine is a very common neurotransmitter in the parasympathetic and sympathetic nervous systems, at the neuromuscular junction, and in the central nervous system (CNS). Inhibition in the parasympathetic nervous system causes bradycardia, myosis, salivation, lacrimation, urinary incontinence, nausea, vomiting, diarrhea, bronchial constriction, bronchial secretion, and pulmonary edema. Enzyme inhibition in the sympathetic nervous system can result in diaphoresis, mydriasis, tachycardia, and hypertension. At the level of the neuromuscular junction, initially the patient would experience increased muscular tone that can lead to muscle fatigue with weakness and can affect diaphragmatic muscles and the ability to breathe. In the CNS, irritability, ataxia, seizures, and coma can result.

However, organophosphate pesticide poisoning can occur with nonspecific symptoms such as abdominal pain, nausea, and diarrhea, which can be misdiagnosed. At the same time, these symptoms are generally not a result of organophosphate pesticide poisoning. The diagnosis must be made using laboratory methods.

The health effects of concern in relation to household exposure to MP are an important consideration. There is currently no data on chronic low-level household exposure, so animal and occupational studies are the only sources of data. For example, a rat subchronic feeding study in which the rats were fed 1/50th to 1/100th of the oral (LD50) of MP showed abnormalities of exploratory behavior in the rats.

In an occupational exposure study, 68 licensed pesticide applicators were compared to unexposed controls. These applicators reported headaches. The study measured vibration sensitivity thresholds in hands and feet and found that the sensitivity threshold was higher in the hands of the exposed group. Exposure was associated with loss of peripheral nerve function.

Dr. Krantz summarized that there are animal studies that show behavior abnormalities from low-level exposure and abnormal cholinergic nervous system development from gestational exposure. A range of occupational studies show some subtle neurological abnormalities despite fairly well-controlled exposures, and some show negative adverse exposures.

In April 1998, EPA received a lead that an applicator had been spraying MP in homes in Chicago. EPA found the man and confiscated MP concentrate from his home. His logbook listed about 400 addresses where he had sprayed, and many of the locations were multifamily units, with each address representing many households. The episode in Chicago was only one of several such cases. Many such application operations are illegal. They generally cater to lower income areas that cannot afford licensed pesticide applicators. Most of the households that were sprayed were on the southwest side of Chicago and in the southside suburbs. These are primarily lower income and African-American areas.

MP has very high acute toxicity and a very low LD50—that is, a very small amount of it can be lethal. The human oral lethal dose is between 50 and 500 milligrams (mg), which translates in a concentrated solution to between seven drops and one teaspoon for a 70-kilogram (kg) adult and between one and ten drops for a 10-kg child. EPA has registered MP for restricted use only. It must be used under the direct supervision of a licensed certified applicator, and there must be no field re-entry within 48 hours of spraying. It is licensed for agricultural use only, and it must be disposed of as a hazardous waste.

MP has low water solubility and low vapor pressure; as a result, it does not migrate far. Like other organophosphates, bioconcentration is not a significant factor. It is degraded by hydrolysis, photolysis, and microbial action. In its usual agricultural applications, it disappears in about 4 to 7 days. When MP is sprayed indoors, however, degradation is slow because there are little light and water. Therefore, the environmental half-life is prolonged. The estimated environmental half-life is 220 days, which translates to about 2½ years before it disappears indoors.

The investigation of the MP episode in Chicago was very much an interagency effort and involved federal, state, and local government agencies. Public health nurses from the Chicago Department of Health and Cook County Department of Health collected urine samples and interacted with the residents. The CDCP analyzed the urinary para-nitrophenols (PNP). ATSDR coordinated the entire public health effort.

The compound MP is metabolized in the body to several metabolites, including PNP. PNP is formed in the liver and is excreted in urine. PNP is excreted within 4 to 8 hours after exposure. In the occupational setting, PNP is used as a biologic exposure index.

The primary route of exposure to MP is dermal. It is oily, so it seeps into wood and other porous surfaces. The Chicago applicator followed fairly predictable spraying patterns, including underneath sinks, along baseboards, and in other areas that might be damp or have roaches. MP is difficult to clean from surfaces. As a surface is wiped, more MP is pulled out onto the surface. Other possible exposure routes include ingestion (for example, through hand-to-mouth activity among children) and inhalation immediately after spraying.

Regarding the intervention strategy used in the Chicago episode, the public health agencies went into homes and conducted environmental sampling in areas that had been sprayed. If samples from a given home averaged greater than 15 μg per 100 cubic centimeters, the family was recommended for biological monitoring. The monitoring consisted of collecting two urine samples per family member for PNP analysis. If any member of the household had a urine sample analytical result that exceeded the age-specific action level, the family was recommended for relocation. If the results were lower, the family was recommended for quarterly monitoring. Most results of the relocations were triggered by infants and children whose results met the lower action levels and showed the highest urinary PNPs. This was to be expected because they were on the floor and touching surfaces more than adults.

Based on information such as logbook addresses, environmental samples were collected at 901 residences. Of those, about 550 residences qualified for biological monitoring. As a result of monitoring, 100 households qualified for relocation involving 579 people, 93 of which were age 3 or less.

In addition, a letter was sent to the residents asking that they call the statewide Poison Center if they had symptoms or concerns about their health. The use of the Poison Center was beneficial because (1) it is open 24 hours a day and (2) its staff is accustomed to triaging patients according to the severity of their symptoms. Patients were seen at Cook County Hospital through an arrangement with ATSDR and the Association of Occupational and Environmental Clinics. The pediatric after-hours clinic at Cook County Hospital assisted by collecting patient information such as medical histories and symptoms at the time of spraying. Physical examinations and laboratory investigations were also conducted for CBC and RBC cholinesterase levels. Of the 67 residents seen at the clinic during the MP crisis, 32 were relocated. The symptoms were fairly consistent, including headaches, nausea, and diarrhea. No residents who visited the clinic had physical

symptoms consistent with organophosphate poisoning. Three residents, all children, had depressed RBC cholinesterases levels.

The initial symptoms were plausibly associated with mild organophosphate poisoning. The urinary PNP levels were generally not in the range where cholinesterase depression is expected. One of the data gaps discovered was that little or no data is available on the normal cholinesterase range for infants.

Cockroaches also contribute to major public health threats, such as asthma in the inner city. Cockroaches, asthma, and illegal use of various pesticides are all related public health issues. There is a need to educate the public about safe ways to control roaches.

In closing, Dr. Krantz commented that the Chicago MP investigation was a very successful endeavor. Factors that contributed to its success were the open communication between many public health agencies, the ability to track cases from the Poison Center, and the fact that a consistent message was given to the public. Hopefully this investigation can serve as a model for surveillance and intervention for other environmental health threats to children.

Dr. Anne Krantz is an attending physician in the Division of Occupational Medicine at Cook County Hospital, where she is on the faculty of the training programs in Internal Medicine, Occupational Medicine, and Clinical Toxicology. She is a consultant for the Illinois Poison Center, and she is an adjunct clinical assistant professor in the Occupational and Environmental Health Sciences Division at the University of Illinois School of Public Health.

Action Levels

Ms. Pam Shubat (Minnesota Department of Health) asked how the age group criteria were established for the Chicago investigation, who was involved, and what endpoints were considered.

Dr. Krantz stated that based on a urinary PNP analysis, the daily ingestion of MP can be determined. There is a reference dose of MP that is an allowable dose. She stated her impression that the action levels were devised so that they were within the realm of reference doses for MP.

Residues

Ms. Katey Sharpe (Pro-IPM Company) asked whether there might be longer-lasting indoor residuals of MP. She also asked whether there were observations of legal insecticides that were misapplied in the affected homes.

Dr. Krantz responded that MP does linger for a long time. In response to the second question, Dr. Krantz stated that she was not sure whether use of other insecticides was systematically investigated and was not aware of a history of organophosphorous use.

Microbiological Pest Control

Dr. Christine Merritt (BioAssay, Inc.) asked whether there was a greater focus now on using microbiological control methods in integrated pest management where the effects are nontoxic.

Dr. Krantz responded that this was not her area of expertise. However, she referred to the EPA handout that focuses on fixing leaks, addressing hygiene issues, using boric acid, and using aerosol pesticides as a last resort.

Developmental Effects of Pesticides and Polychlorinated Biphenyls

NEURODEVELOPMENTAL EFFECTS OF PCB EXPOSURE

Dr. Christopher DeRosa
ASTDR

Dr. Christopher DeRosa outlined his presentation as (1) an overview of why ATSDR is interested in endocrine disrupters, (2) a case for biologic plausibility, (3) a discussion of low dose exposures, and (4) some thoughts for the future. Dr. DeRosa broadened the focus of his presentation to address halogenated aromatic hydrocarbons instead of just PCBs.

ATSDR has developed a list of 275 priority pollutants, and more than half of those compounds have been implicated as possibly being endocrine disrupters. ATSDR has a vested interest in those chemicals because they are often found at Superfund sites. ATSDR is also involved through the Great Lakes Human Health Effects Research Program. Despite their vast size, the Great Lakes are very vulnerable to accumulation of toxics, and 362 chemicals have been identified in the sediments, biota, and water of the Great Lakes. The National Joint Commission identified 12 substances that were of particular concern because of their persistence, lipophilicity, and ability to biomagnify through the food chain to humans.

In addition, ATSDR is involved through the Childhood Health Initiative. About 40 documents related to the new sections of the Toxicological Profiles will be available in fall 1998. They will be a series of stand-alone sections that address health effects and exposures, define children's susceptibility, and identify data needs in these two areas. One of the goals is to move science into a position of service by developing a public health statement that is written at a seventh-grade reading level and addresses questions commonly asked by the public and physicians. The statement would address how a chemical can enter the body, the effects of the chemical, how it can be eliminated, where more information can be obtained, and (with an emphasis on primary prevention) how families can reduce the risk of exposure for their children.

Dr. DeRosa presented the case for biologic plausibility. He stated that evidence began to accumulate in the early 1960s with Rachel Carson's book, *Silent Spring*, which discusses the destruction of birds' "capacity to reproduce" by herbicides and insecticides. Since that time, poor reproductive success in marine birds, mammals, reptiles, and fish, has been documented in the Great Lakes and elsewhere.
Evidence continues to accumulate, including reproductive and developmental effects resulting from disrupted endocrine function, compromised immune function, and cancer. Canadian researchers are in the forefront, having coined the term Great Lakes Embryonic Mortality and Edema and Deformities Syndrome (GLEMEDS) to describe a characteristic set of effects observed in the wildlife population of the Great Lakes

basin. For example, in the case of birds, there were supernumerary digits on the feet, crossed bills, and feathers on newly hatched chicks like the feathers on mature adults. These characteristics are not limited to the Great Lakes basin.

The findings of the wildlife biologists provided an impetus for one of the more compelling of the early epidemiologic studies. Human health effects associated with consumption of contaminated Great Lakes fish were examined in a Michigan maternal/infant cohort study. The study tracked 242 mother-infant pairs and found physical indicators of impacts on mothers who were exposed through eating of fish 6 years prior to and during pregnancy. PCBs were one of the primary contaminants of concern. Decreased gestational age (4.9 days), birth weights (160 to 190 grams [g]), and head circumference (0.6 centimeter [cm]) were observed. Some behavioral anomalies were also observed in the form of depressed responsiveness, impaired visual recognition, and poor short-term memory as measured on the visual-recognition memory test. Follow-up after 4 years showed that these deficits persisted. In addition, a recently published 11-year follow-up in the *New England Journal of Medicine* shows that the children were twice as likely to be at least two grades behind in reading comprehension, were three times as likely to have a low-normal IQ, showed poor short- and long-term memory, and had difficulty paying attention.

Another study, the North Carolina breast milk and formula project conducted by NIEHS, addressed over 800 mother-infant pairs with background exposures to PCBs. The research team saw a recapitulation of the behavioral deficits reported by the previous study. The behavioral deficits did not persist when the children were tested at 3 years of age. In another study, children of mothers occupationally exposed to PCBs exhibited decreases in gestational age (6.6 days) and birth weight (153 g).

Regarding low dose exposures, Dr. DeRosa reported that EDSTAC had recently approached ATSDR to address this issue. The investigation primarily examines the health impacts of eating contaminated fish.

Based on the findings of the ATSDR research program related to exposures, demographics, and health effects, the epidemiological studies show that exposure to persistent toxic chemicals of concern is continuing and that fish consumption is the major pathway for that exposure. There is a significant trend of increasing body burdens with increased fish consumption; the body burdens are generally three or four times higher than those of the general population. The at-risk populations that ATSDR has identified include Native Americans, sport anglers, the elderly, pregnant women, fetuses, nursing infants, women and men of reproductive age, and immunologically comprised persons.

An ATSDR-sponsored Great Lakes human health effect research study shows neurobehavioral and developmental effects in newborn infants of mothers who consumed Great Lakes fish. It was a prospective longitudinal study made up of 536 mother-infant pairs. The study reported a greater number of abnormal reflexes and less mature autonomic reflexes. The children were easier to startle, based on results from the Brazelton neonatal behavioral assessment scales. The study revealed no deficits in terms of range and regulation of state, orientation, and motor development. The study controlled for 133 confounding factors, including socioeconomic factors, delivery and labor considerations, and exposure to other substances.

A second study reports that exposure to environmental chemicals through consumption of contaminated sport fish may delay time-to-pregnancy among women who have consumed fish for up to 7 years prior to conception. A total of 11,000 people were in the cohort. A third study reports increased incidence of diabetes, muscle and joint pain, liver disease, and memory loss.

Toxicology has provided many of the insights at the subcellular, cellular, and organismal levels that account for what has been observed at the population level. Some of the effects observed in the toxicological setting include immune effects and liver enlargement. The premise of toxicology is that animal models can be used to project what is going on in the human population. Although good exposure data is generally lacking for human populations, body burden data is primarily available. In contrast, exposure levels are well characterized in animal studies, but body burden data is lacking for those populations. The question then remains, "How do we make the leap from exposure levels in rodents to effect levels in humans?"

Finally, Dr. DeRosa presented ATSDR's framework for the future of public health and the experimental realm. EPA and 13 other federal agencies were convened by the President's Committee on the Environment and Natural Resources. The consensus was development of a research inventory representing a compilation of the total research underway in the areas of human health, ecological efforts, and exposure. About two-thirds of the over 400 studies are in the human health area, with the balance being equally divided between ecological assessment and exposure studies. Most of the studies address dioxins, PCBs, and heavy metals. Given the current level of resources, adequate testing of the 60,000 to 70,000 chemicals commonly in use would require approximately 1,000 years. In addition to screening and testing techniques in traditional laboratories, computational toxicology is increasingly important in extending the plausible range in biologic inferences and extrapolations that are needed to deal with uncertainties in health assessments. Increasing creativity is needed, such as that shown in an example from a meeting of NIEHS in Tokyo, where a laboratory is attempting to look at combinatorial complexity in terms of predicting the overall direction of hormonal receptor interactions.

A growing body of evidence suggests that substances that are structurally analogous to hormones may have a serious impact on reproductive and developmental parameters, especially in populations that are vulnerable by virtue of their physiological sensitivity or elevated exposure. The implications of these noncancer health impacts have often been overlooked.

Dr. DeRosa stressed the need to have additional research tools in place to better characterize the potential for transgenerational effects on developing and mature organisms. He stated that it is known that the receptors in every tissue and cell are present at a level that is defined by their exposure to hormones during development. This can set the stage for differences in the population ecology of these receptor populations in the different tissues and organs later in life. He stressed the need for *in vivo* and *in vitro* methods to screen and test a broad range of chemicals, particularly at low doses or background levels, for their endocrine disruption ability.

Dr. Christopher DeRosa is Director of the Division of Toxicology at ATSDR and previously served as ATSDR's Deputy Associate Administrator for Science. He also worked in several capacities at EPA in Cincinnati, Ohio, including Branch Chief of the Chemical Mixtures Assessment Branch and Acting Director of the Environmental Criteria and Assessment Office. Dr. DeRosa has been the recipient of the EPA Bronze Medal four times and of special achievement awards for continued superior performance.

Great Lakes Fish

Mr. Eric Uram introduced Sammy the Salmon, mascot of the Sierra Club's Great Lakes Program and a symbol of the Clean Water Safe Fish Program. The program's message is that the chemicals in Great Lakes fish are causing learning disabilities and cancers in populations at risk. With fish being the primary route of exposure and with the ATSDR fish eater study showing that two-thirds of the women and 80 percent of the minority population are unaware of fish consumption advisories, Mr. Uram asked what is being done to raise awareness.

Dr. DeRosa stated that ATSDR's program has placed emphasis on development of risk communication and health education strategies targeted toward at-risk populations. The challenge is how to generalize information and make it broadly available. A community involvement effort underway at ATSDR and the idea of strategically targeting the message to the community (including its schools and churches) are very important to getting the message out.

Mr. Uram stated that there was reluctance among public health officials at the local and community levels when the Sierra Club tried to work with them. He stressed that there was a dire need for awareness.

Dr. DeRosa stated that his organization had encountered similar reluctance in public health agencies. In the past year, ATSDR has worked with EPA to develop fish advisories and has mailed them (over 1 million copies) to fishing license holders, local health departments, pediatricians, and 40 tribal nations among others. Dr. DeRosa agreed that it is a question of building partnerships at the state and local levels.

Cost to Society

An unidentified audience member asked whether anyone has tracked children who have been diagnosed as having impaired learning abilities. The cost to society for these children, who have unsuccessful academic careers and a pattern of failure in school, should be evaluated. Historically, these children are the ones who become drug addicts and predators in society, and they may develop a pattern of criminal behavior as a result of their unsuccessful school careers.

Dr. DeRosa stated that these deficits need to be recognized but that the cost to society is difficult to determine.

Public Education

Ms. Liane Caston (Chicago Media Watch) stated that in 1993, the IJC recommended removal of certain toxic chemicals from the market, including DDT, toxaphene, dieldrin, mirex, and hexachlorobenzene. However, EPA has not gone along with the IJC recommendation. She commented that while public education is a recurring message at the conference, there does not appear to be a collective will to stop these chemicals at the source.

Dr. DeRosa pointed out that there have been successes in the area of pollution prevention, a key feature of EPA's Office of Prevention, Pesticides, and Toxic Substances program. For example, in 1989, 2.4 pounds of dioxins was emitted from about 185 paper mills in the Great Lakes area. In 1993, that number had been reduced to 8 ounces. However, the message of success must be tempered with the fact that pollution is an international phenomenon. Despite pollution prevention successes in the Great Lakes basin, PCB levels, which had been coming down for a number of years, have plateaued. Recently at the Persistent Organic Pollutants (POPs) Treaty meeting in Montreal, Canada, Russia admitted for the first time that it is still producing PCBs, which accounts for 90 percent of the PCBs coming into Lake Michigan via atmospheric transport. DDT levels have also plateaued, possibly because of DDT's off-shore use in the Caribbean basin. The POPs Treaty provides an international forum to get agreements to reduce or phase out the use of these compounds.

Developmental Effects of Lead

CHILDHOOD LEAD POISONING: WHAT'S NEW, WHAT'S SADLY NOT

Dr. Michael Weitzman
University of Rochester

Lead is one of the great pediatric public health success stories. However, although there are many reasons to celebrate the successes over the last 30 years, the lead story is not over yet. There is still a huge amount of lead in the environment, and this remains one of the most pervasive child health problems in the United States.

According to data from the National Health and Nutrition Examination Survey, which provides representative data for all the children in the United States, the mean blood lead levels of children ages 1 to 5 years have declined. The United States has come a long way since 1971 with very limited resources. It appears that the greatest impact was related to lead in gasoline, whose levels in emissions were reduced by catalytic converters in cars. However, there are many questions regarding childhood lead poisoning, including the following:

- Has childhood lead poisoning largely been eradicated?
- What are the neurocognitive effects and the clinical importance of low-level exposure?
- How does one accomplish targeted screening?
- How do we increase lead screening?
- How effective are medical management, advice to parents, and environmental intervention?
- What is the utility of educational and environmental intervention?
- Is there a role for oral chelators in treating children with blood lead levels of 25 to 44 μg/dL?
- What constitutes appropriate developmental testing and intervention?

Dr. Weitzman defined low blood levels of lead as 10 to 30 μg/dL. Neurotoxic effects of low-level lead exposure include diminished IQ levels and impairments in short-term memory, reaction time, ability to concentrate, visual-motor perceptual integration, hearing, and social behavior.

After an exposure, the half-life of lead in blood tends to be about 28 days. Lead is deposited in the liver and kidneys and largely in the bones, and the end organ of concern is the brain. "Lead lines" or growth arrest lines occur in bones after an acute exposure to lead. This provides a lifetime repository in a child's body, and lead is released over the child's lifetime.

There is a changing perception of lead poisoning. Twenty-five years ago, it was thought of as a disease typified by encephalopathy, convulsions, coma, and death associated with eating paint chips. Today it is regarded as an asymptomatic disease linked to multiple sources with toxic effects at levels previously thought

to be safe. This is reflected in the fact that CDCP has continuously lowered the action level for lead. In the 1960s, it was 60 μg/dL; in 1975, it was lowered to 30 μg/dL; in 1985, it was lowered to 25 μg/dL; and in 1991, it was lowered to 10 μg/dL. There are people who believe the action level should be still lower.

There are marked limitations to conventional treatment. There is no evidence that chelation (leaching of lead) can repair neurologic damage; it does not reduce brain lead and may actually increase it, depending on the chelator used. In addition, the treatment is expensive and potentially painful and dangerous. Most importantly, it is not effective if the child goes back to a lead-infested environment.

Lead is a multimedia exposure problem. Children are exposed to lead from many different sources, such as paint, dust, soil, water, food, and food containers. The most ubiquitous and concentrated source of their exposure is paint in and around their homes. About 10 to 15 years ago, pica behavior and peeling and chipping paint were considered the major sources of exposure to lead. However, most lead exposure involves hand-to-mouth activity that is quite normal for children.

From 1976 to 1980, 88 percent of children had blood lead levels over 10 μg/dL; in 1998, it is down to 4.4 percent. However, Dr. Weitzman acknowledged that issues can be hidden or misrepresented in data. For example, there are marked racial, economic, and ethnic differences associated with children's blood lead, such as the percentage of lead in blood decreasing higher in the income gradient.

Housing is the most likely source of exposure for most children. Housing built before 1950 poses the greatest risk for lead exposure because it is much more likely to contain lead-based paint than is newer housing. The Consumer Product Safety Commission regulates the amount of lead in paint. As of the late 1970s, the commission greatly reduced the amount of lead in household paint. This led to practical suggestions to help people who live in affected homes. Unfortunately, there are still public health and pediatric systems that are triggered only when a child has unacceptable levels of exposure. Suggestions to avoid lead hazards in the home include the following: (1) stabilize or cover lead paint; (2) move cribs and playpens away from peeling paint; (3) wet mop floors and wet-clean window sills and wells with high-phosphate detergents; (4) avoid dry dusting or sweeping; (5) regularly wash children's hands, toys, and pacifiers; and (6) use cold water for cooking and run water for 2 to 3 minutes each morning.

The blood lead issue does not pertain only to children growing up in poverty. Lead poisoning has also resulted from renovations in middle-income family housing. Recommendations to reduce lead hazards in this situation include the following: (1) inform families that all preschoolers are at risk, especially if living in or

regularly visiting pre-1960 homes; (2) use trained contractors for renovations and paint removal in old homes; (3) keep the family out of the home during remodeling; and (4) complete post-abatement cleanups, ideally using professional cleaners.

The 1997 CDCP Lead Poisoning Prevention Guidelines no longer emphasize universal screening but instead focus on targeted screening. The goal is to ensure that children at risk of exposure to lead are screened. Although the revised guidelines have moved toward targeted screening, the guidelines call for universal screening for (1) areas that have sufficient data to show that more than 12 percent of 1- and 2-year-olds have blood lead levels greater than 10 μg/dL, and (2) areas in which the prevalence of children with elevated blood lead levels is unknown, but more than 27 percent of housing was built before 1950. Dr. Weitzman advised that other children needing screening include those whose parents have high-risk jobs or hobbies, children who emigrated or were adopted from high-risk areas, and children who have traveled to high-risk areas.

Unanswered questions remain:

- Is there a clinically significant effect of lead at a level less than 20 μg/dL? (An average of 2.5 to 4 IQ points are lost for every 10-μg/dL increase above 10 μg/dL.)
- If the blood lead level is reduced, will cognitive function improve?
- Can efforts to decrease lead exposure have a clinically significant effect, and at what cost?
- Do all young children living in pre-1950 housing need to be tested?
- Is 10 μg/dL appropriate as the lower level of concern?
- Is there a specific neurobehavior signature?
- Are the major negative effects in the area of IQ decrements or more subtle cognitive and behavioral dysfunctions?
- Is there a critical age for exposure?
- Are neurotoxic effects more influenced by length or peak of exposure?
- Is linear across all levels of exposure?
- Is lead poisoning reversible?
- What is the role of intervention?

In closing, Dr. Weitzman stressed that the public must recognize that this problem has not been solved, that this is a problem that is entirely the making of humankind, and that a way must be found to prevent it.

Dr. Michael Weitzman is Pediatrician-in-Chief at Rochester General Hospital and Associate Chairman of Pediatrics at the University of Rochester School of Medicine and Dentistry, where he also is the Director of the Division of General Pediatrics. Dr. Weitzman was formerly Director of Maternal and Child Health for the City of Boston and Director of General Pediatrics at Boston City Hospital and Boston University School of Medicine. Dr. Weitzman also currently serves as the chairperson of a number of advisory committees, and his teaching efforts have resulted in prestigious awards.

Hemoglobin

Dr. Jewel Crawford (ATSDR) asked how well lower hemoglobin and hematocrit correlate with low blood lead levels. She thought that many practitioners do not check blood lead levels but look for anemia, after which they perform screening. She asked if that was adequate.

Dr. Weitzman stated that hemoglobin is not a good screening parameter. When a person becomes iron-deficient, he or she is more efficient in absorbing lead. Children will absorb more lead if they are iron-deficient. There is also literature that shows neurocognitive problems associated with iron deficiency similar to those associated with lead. Whether these are confounding or separate issues still needs to be addressed.

Universal Screening

Dr. Alan Woolf (Boston Poison Center) stated that he is unclear about the 1997 CDCP guidelines mandating universal screening if 12 percent or greater of 1 to 2-year-olds have blood lead levels greater than 10 μg/dL. He asked how a physician would know that the prevalence within the community is greater than 12 percent? It seemed to him like circular logic.

Dr. Weitzman agreed that it was circular logic. The real issue is that very few communities have enough data to make that kind of decision. There have been at least half a dozen papers, some from suburban Chicago, showing that it costs hundreds of dollars to identify a single child with elevated blood lead levels.

Developmental Effects of Lead

DEVELOPMENTAL EFFECTS OF LEAD

Dr. David Bellinger
Children's Hospital, Boston

Dr. David Bellinger stated that as a result of the large amount of research that has been done in the last 50 years, lead is unique in terms of the data available. This data has provided a series of reductions in the amount of lead that is considered "too much" for children. In the late 1960s, the acceptable blood lead level was 60 μg/dL; by the early 1990s, that was reduced to 10 μg/dL.

The reasons that children are the population subgroup at greatest risk of lead exposure fall into two broad categories, behavior and physiology. In terms of behavior, certain activities among children bring them in greater contact with materials that are lead-laden, including their play patterns and hand-to-mouth activity. Physiological characteristics include gastrointestinal absorption, dietary intake per unit body weight, respiratory volume relative to body size, distribution of lead in the body, and maturity of the nervous system. Lead is also handled differently in the bodies of adults than in the bodies of children. In adults, 90 to 99 percent of the total body burden is sequestered in bony tissue. In children, only 70 percent is suppressed, thereby making it more bioavailable to soft tissue such as the brain.

Dr. Bellinger presented conclusions in the current literature on lead and children's intellectual function as well as several critical characteristics of that relationship. Factors include (1) consistency of dose-effect estimates of the magnitude of the decline in cognitive function, (2) threshold or lowest observed adverse effect level, (3) periods of increased vulnerability, (4) persistence or reversibility, and (5) behavioral signature.

With respect to consistency of dose-effect estimates, most of the data in the literature addresses IQ. Despite substantial differences in various epidemiological studies, there are similar results with respect to the slope of the decline in IQ with increasing lead. In seven European studies, a consistent downward slope was observed. In another six studies that relied on the tooth lead level as an indicator of exposure, more lead in teeth correlated with lower IQ scores. A meta-analysis conducted by the International Program on Chemical Safety of the World Health Organization concluded that the size of the apparent IQ effect at age 4 and above is a deficit between 0 and 5 points for each 10-μg/dL increase in blood lead level, with a likely effect size of between 1 and 3 points. In addition, a British biostatistician conducted a meta-analysis and found that an increase in blood lead from 10 to 20 μg/dL or in tooth lead from 5 to 10 parts per million (ppm) is associated with a mean deficit in full-scale IQ of 1 to 2 points. The evidence suggests a consistent but modest inverse association.

In terms of threshold or the lowest observed adverse effect level, Dr. Bellinger stated that it is difficult to identify a lead level below which there is no inverse relationship between IQ and lead levels. The current CDCP number of 10 μg/dL has no special biological significance.

In one study involving a group of children who experienced low exposures, the mean blood lead level in the children never exceeded 8 μg/dL between birth and 10 years of age. However, when their IQ was examined at 10 years of age, there was a decline in performance according to a full-scale IQ test and the Kaufmann Test of Educational Achievement.

Researchers generally perform linear regression in their studies, which forces a straight-line fit onto the data. As a result, there is by definition no point of inflection and no opportunity to see a threshold in the data. However, nonparametric smoothing statistical methods allow data to reveal the functional form of the relationship, whether a straight line is the best fit or there is a point of inflection. Dr. Bellinger and his team used this approach and found that any lead has an effect: a small but noticeable inverse relationship is observed even at low lead levels.

Several lines of evidence suggest that present-day burdens, even though they have declined in the last 20 years, are still two to three orders of magnitude higher than the natural background level that humans had before lead was mined. For example, a study published in the *New England Journal of Medicine* defined a best-fit regression line based on the known relationship between blood lead and bone lead in a variety of animal and human samples. A blood lead level of 0.016 μg/dL is the estimate of what human levels were or should be based on measurements of skeletons from before lead was mined. This is more than two orders of magnitude lower than the current average in children. Dr. Bellinger stated that it is not surprising that a threshold has not been determined as everyone is currently over the threshold.

The issue of periods of increased vulnerability involves whether there is a particular age that is worse to be exposed to lead. In most cohorts, blood lead and age are highly confounded, with blood lead peaking at around 2 years of age. The Cincinnati Prospective Blood Lead Study involved collecting numerous blood lead samples during children's early years. Regardless of whether a child was least exposed or highly exposed, it was around age 2 that blood lead peaked.

One issue involves blood lead tracking. A child with a high blood lead level relative to his peers at one age tends to have high levels relative to his peers as he ages. If a child's blood lead level increases and remains high, that reduces the opportunity to identify age-specific differences in vulnerability.

Exposure to lead from 1 to 3 years of age appears to be the most hazardous to children. Based on a study in Boston, when children get into their second year of life (postnatally), the regression coefficients become negative, indicating an inverse association. Around 2 years of age, the relationship reaches statistical significance at a 95 percent confidence interval. In the study's particular cohort, blood lead tracking was not an issue. In this cohort, the blood lead level at age 2 was a better predictor of IQ at age 5 or 10 than was the maximum blood lead level that the child had at any time that was measured over the course of the study.

Another meta-analysis also confirmed these findings. In this analysis, the decline in IQ was plotted for different blood lead indices: the postnatal mean, the blood lead at age 2, and the blood lead at birth. It was the blood lead at age 2 that was the most consistent in terms of the inverse association with later IQ. It is ironic that children tend to be most exposed to lead at precisely the time that the nervous system may be the most vulnerable—around 2 years of age. Lead is known to affect every neurotransmitter system that has been studied. Lead affects the second messenger system, which involves propagation of chemical impulses within cells. In addition, it affects adhesion molecules that regulate fiber outgrowth and rooting.

Regarding persistence or reversibility, data is difficult to obtain because some exposure occurs throughout life from both exogenous and endogenous sources. Instead, the issue should be whether there is an increase in performance if a child's exposure is reduced. Other issues involve the different instruments used to track cognitive function and differences between what is measured in a 1-year-old and a 4-year-old.

Dr. Bellinger stated that in his Boston study, through 2 years of age, children with high cord blood lead levels (defined as >10 μg/dL) did perform significantly worse than children who had lower median lead levels in their cord blood. However, by the time that the children reached age 5, it appeared that they recovered to some extent. Children that had high cord blood lead levels but low concurrent levels at age 5, showed good improvement in their performance between ages 2 and 5. They showed an increase of 6 points on an IQ test. Children who had high cord blood lead levels and whose blood lead levels remained high at age 5 showed a continued decrement in performance.

The apparent disappearance of an adverse impact does not mean that there is not some subtle functional reserve capacity effect that may be expressed when the child is faced with physiologic or pathophysiologic stress. A latent effect may be expressed in times of great stress later. There is evidence in both animal and human studies of such an effect.

In terms of a signature behavioral injury, Dr. Bellinger stated that in his view, there is no such injury that identifies that a child has been overexposed to lead. There currently is no particular constellation of neuropsychological findings that can be used in the diagnostic sense. Some studies indicate that verbal abilities are most impacted by lead, while others indicate that the visual and spatial abilities are most affected. The most consistent finding is the reduction in the ability to sustain attention.

In closing, Dr. Bellinger acknowledged that there are a lot of questions that remain unanswered with respect to lead. It is unknown what the conditions are, if any, under which deficits are reversible. The determinants of individual variability and vulnerability are unknown, and the mechanisms of toxicity are yet to be understood.

Dr. David Bellinger is a research associate in neurology in the Neuroepidemiology Unit at Children's Hospital, Boston, and an associate professor of neurology at Harvard Medical School. Dr. Bellinger is also the Director of Research in the Behavioral Pediatrics Fellowship Program and Co-Director of the Children's Hospital Learning Disabilities Research Center. Dr. Bellinger is the past recipient of a Research Career Development Award from NIEHS. Dr. Bellinger has served on advisory groups of the National Research Council, the World Health Organization, ATSDR, CDCP, EPA, and the Food and Drug Administration.

Blood Lead Testing and Women

Ms. Michelle Palmer (EPA) asked whether Dr. Bellinger would recommend blood lead testing for women of childbearing age because of the concern about exposing children *in utero*.

Dr. Bellinger responded that it was a tricky issue and referred to New York as a state that has been wrestling with that question. He stated his opinion that girls should be tested well before childbearing age. However, if girls are found to have blood lead levels in an area of concern with respect to exposure at childbearing age, he was not sure what should be done. Dr. Bellinger cited this as another example of the need to take a generational approach to the issue. That is, there is a need to address the primary prevention issues now and then hope to reap the benefits of those efforts in following generations.

Developmental Effects of Lead

A CHICAGO PUBLIC HEALTH DEPARTMENT RESPONSE TO LEAD POISONING

Ms. Jonah Deppe
Chicago Department of Public Health

Ms. Jonah Deppe stated that there has been a lead poisoning prevention program in Chicago for over 20 years. The program involves screening children, conducting inspections, and identifying hazards. The general public perception was that these three steps would take care of the problem. The 1996 screening data for Chicago shows a high number of children having elevated lead levels. According to the 1990 census, there are approximately 294,000 children under age 5 living in Chicago. About one-third of these children are tested on an annual basis. These statistics are only for those children whom laboratories or physicians have reported. There are probably other cases that have not been reported. There were 21,558 children in 1996 with blood lead levels of 10 μg/dL and above. Since the Illinois Lead Poisoning Prevention Act was amended in 1991 to require physicians to screen children, approximately 60 percent of children in Chicago are screened by private physicians or clinics. Another 30 percent of them get screened by Chicago Department of Public Health (CDPH) clinics or through outreach screening.

CDPH is a delegate agency for the Illinois Department of Public Health. The Lead Poisoning Prevention Act, which was passed in the 1970s, was amended in the early 1990s. The entire city of Chicago is a high-risk area. In Chicago, 59 percent of the housing was built before 1950. As a delegate agency, CDPH has the responsibility of conducting home inspections for children with blood lead levels of 25 μg/dL and higher.

CDPH has established a system to conduct investigations and locate children. Illinois requires all lead results to be reported to the state's reporting system. On a daily basis, the results are transferred electronically to the City of Chicago database. CDPH uses a CDCP database to track the children. If a child has a blood lead level of 25 μg/dL or higher, CDPH provides a public health nurse home visit. If too many new children are identified in a week, CDPH resorts to triaging in which materials and a hotline number are provided for parents to use. CDPH conducts follow-up telephone calls to see whether a child has been assigned a health care provider.

CDPH has difficulties in conducting inspections. One of the problems is that the data Chicago receives is incomplete. Full addresses and parents' names are often missing. The public health nurses have to become detectives to locate the children. Once in the homes, the inspectors identify hazards and teach the families remediation techniques. All inspectors have also been trained to be risk assessors. The public health nurses strive to get into a home within 10 days if a child has a blood lead level between 25 and 45 μg/dL. If the

blood lead level is 45 μg/dL or higher, the inspection should be completed within 48 hours. If the blood lead level is 70 μg/dL or higher, someone is dispatched immediately, especially if the patient does not have a primary care physician.

Substantial changes have been made in the inspection process to focus on intervention as opposed to citing people who have violated building codes. CDPH strives to teach property owners to mitigate and remediate. When conducting an inspection, the inspector spends time with the family and, if available, the property owner. The inspector reviews the hazards found and determines what action can be taken. If no hazards are found in the home, the inspector investigates where else the patient might be exposed, such as at a daycare center.

Out of the approximately 5,000 new children that are identified annually, home inspections are done for about 1,700 to 2,000. Some people are difficult to locate, while others refuse because they are fearful of "inspectors." There have been cases where parents do not know that their children are lead-poisoned until the nurses knock on the door.

The State of Illinois now requires that once an inspection has been completed, the property owner must prepare a mitigation plan within 30 days. The property owner receives a letter stating that an inspection has been conducted, stating the law, and listing all hazards found. Property owners are often reluctant to allow inspectors to conduct subsequent inspections because of the anticipated cost of mitigation. Inspectors are working more closely with property owners to resolve these issues. For example, if the mitigation plan is not completed within 30 days, the deadline may be extended as long as interim measures are in place.

CDPH inspectors are conducting workshops for property owners and others interested in fixing up their neighborhoods. This form of community outreach also helps people to trust CDPH. More proactive approaches are needed to complete lead abatement.

Ms. Deppe concluded that the lead issue is not just a public health issue. It is an issue of housing that requires getting involved in each community.

Ms. Jonah Deppe is Program Director for CDPH's Environmental Lead Program. In this role, Ms. Deppe is responsible for administration of the Investigation and Enforcement Unit, Surveillance Program, Outreach Screening, and Coordination of Follow-up with Public Health Nurses. Ms. Deppe was Program Administrator for the Childhood Lead Poisoning Prevention Program for the Illinois Department of Public Health. Ms. Deppe developed and implemented a statewide program with local health departments to prevent childhood lead poisoning.

Property Owners

Ms. Pat Van Leeuwan (EPA) asked whether most of the property owners are large owners who can obtain training on their own or smaller, private owners.

Ms. Deppe responded that most of the owners are private owners of two- to four-flat homes. In certain neighborhoods, a large percentage of the owners are grandparents who are raising children. They are generally on a limited income, so maintaining and fixing up their homes can be a problem. Ms. Deppe acknowledged that there is not much money available to help property owners resolve the problem.

Lead Poisoning and Asthma

Ms. Kelly Ambler (University of Chicago) asked whether there is an overlap between people who have lead poisoning and those with asthma.

Ms. Deppe stated that children with lead poisoning generally do not have asthma. However, the two groups share common problems such as dust.

Closing Session

CLOSING SPEAKER
Ms. Romona Trovato
EPA Office of Children's Health Protection

Ms. Romona Trovato discussed progress at the federal level not already covered during this conference. The Office of Children's Health Protection was created by EPA Administrator Browner in May 1997. The purpose of the office is to address children's health using a very holistic approach and to incorporate children's health issues into EPA's systems. The office will cease to exist once regional and program offices and state agencies address children's health issues.

Ms. Trovato then described why and how the office was formed. A 1993 National Academy of Sciences report titled "Pesticides in the Diets of Infants and Children" states that exposure to children is probably greater than anticipated. In addition, children are not little adults in terms of health risk. Although this idea is not new to pediatricians, it is new to risk assessors. In addition, other alarming statistics exist, many of which were discussed during this conference.

As a result, Congress unanimously passed the FQPA in 1996, which directs EPA to address children's issues much more than ever before. It expands EPA's testing authority, requires a tenfold uncertainty factor for infants and children in the absence of reliable data, and requires examination of "common mechanisms of action" and "total exposure." The SDWA, also passed in 1996, requires EPA to consider disproportionately affected subpopulations, including children.

Administrator Browner issued a National Agenda to protect children's health from environmental threats. Although this approach may seem logical today, laws have traditionally been written with adults (specifically healthy adult white males) in mind. In addition, except for lead, nitrate, and nitrite, not much data are available for other chemicals. As a result, EPA has implemented a research strategy to determine how children are affected by exposure to chemicals. EPA is also expanding community right-to-know and educational efforts for parents, teachers, health care providers, and environmental professionals. Pediatricians are knowledgeable about children but not about the environment; therefore, a partnership is necessary. EPA has invested more in children exposure issues within the last 2 years than before.

The April 1997 Presidential Executive Order calls for a multi-agency federal task force to focus on priority areas. First, the task force was charged with developing a federal government-wide research strategy headed by representatives from EPA's Office of Research and Development and NIEHS. To accomplish this task, an

inventory was taken of all government research in the area of children's environmental health and entered in a database that will be available in December 1998. The database will be reviewed for data gaps that hinder the passing of standards protective of children. The Executive Order also states that every regulation that any federal agency writes that is economically significant (that is, the regulation would cost the country $100 million or more) must consider children.

In terms of science, the Office of Children's Health Protection is striving to establish Pediatric Centers of Excellence consisting of universities or medical schools that will research specific children's health issues related to the environment. Six to eight designated centers will be announced in August 1998. EPA is also developing risk assessment guidelines to include children in risk assessments. The Office of Children's Health Protection also sponsored a cancer conference in September 1997 and held a supplemental environmental perspectives session in June 1998. Based on the conference, EPA and ATSDR have published a cancer agenda that includes issues to consider with regard to children.

In terms of regulatory efforts, the Office of Children's Health Protection has disseminated regulatory guidance to EPA rule writers that requires consideration of impacts on children in the preamble to each regulation written. In addition, the office is developing a practical guide to cost-benefit analysis. To support any regulation written, EPA must report what it costs and how it would benefit the country. If the benefits outweigh the costs, then the regulation will be approved. EPA traditionally focuses on costs more than benefits. Ms. Trovato stressed the need to refocus to examine the benefits of preventing children's diseases. She also urged that EPA refocus on mortality instead of morbidity and the number of lost days of work and loss of productivity to society. She reported that asthma cost the country an estimated $6.2 billion in 1990.

In terms of communications and outreach, EPA is striving to educate the public on children's health issues to encourage personal responsibility. EPA's Child Health Champion campaign is a 1-year pilot involving 11 demographically and geographically diverse communities. The goal of the campaign is to determine the kinds of information needed by communities to take action on their own and to understand how EPA can assist in providing the information. The cooperation of state and local public health agencies is key to this effort and much of the work will be coordinated with these agencies.

An inventory of EPA's children's health activities will be available in August 1998. The inventory will include EPA actions by disease category instead of by statute. The Office of Children's Health Protection webpage address is *http://www.epa.gov/children*.

The Presidential Task Force established by the Executive Order is co-chaired by EPA Administrator Browner and Health and Human Services Secretary Donna Shalala. There is cross-agency representation in four committees within the task force to focus on asthma, unintentional injuries, childhood cancer, and developmental disorders. The committees were tasked with developing strategic agendas for each of these areas. The agendas will be presented to the task force for comment. Ultimately, a budget will be developed to support the agendas. A very extensive agenda on asthma and unintentional injuries is anticipated by the end of July 1998. The committees on childhood cancer and developmental disorders are progressing.

EPA's primary role in protecting children is to write and enforce regulations. EPA can also obtain data and determine risks. At EPA Headquarters, standards are being written while enforcement and outreach are occurring in the regions. Performance partnership grants in the states allow states to use the money to address the most significant issues. Ms. Trovato acknowledged that Indiana and Illinois have launched very targeted and forceful efforts in the area of children's health protection.

In closing, Ms. Trovato stated that much is occurring on a national scale to drive EPA and other agency actions. One of Ms. Trovato's goals is to forge a better partnerships between the environmental movement and public health community.

Ms. Ramona Trovato is Director of the EPA's Office of Children's Health Protection, where she provides leadership on various children's health issues. Ms. Trovato has been with the EPA for 25 years and has held many technical and high-level management positions.

Closing Session
CLOSING SPEAKER
Dr. Robert Amler
ATSDR

Dr. Robert Amler began by referring to a diagram drawn by Ms. Florence Nightingale in 1854 to illustrate the extent of preventable deaths in British military hospitals. The vast majority of deaths were preventable; very few were from battle wounds. After Ms. Nightingale presented these findings and sanitary measures were implemented, the number of preventable deaths declined dramatically. By 1855, the mortality rate dropped by 50 percent in soldiers to 2 percent. The key was that once Ms. Nightingale made her observation, she displayed it, described it, and pursued it with the British military command. Dr. Amler acknowledged that she was a remarkable figure.

Dr. Amler then moved his focus to twentieth century infectious diseases. He discussed the iron lung, which is unnecessary now because of the elimination of polio in North America. In the Western Hemisphere, a case of wild polio has not occurred since 1990. Again, the key is recognizing the problem and pursuing public health work.

In the second half of this century, new killers have emerged, including tobacco, alcohol, high blood pressure, car-related deaths, overnutrition, and lack of exercise. Like the last century, this century is closing with recognition of the leading killers. Related deaths are beginning to decline even while more is learned about mechanism and cures. Life expectancy at birth in the year 1900 was less than 50 years, but life expectancy in the year 2000 will be almost 80 years.

Currently, there has been a shift toward a new paradigm—that of caring for our children. It is now recognized that certain developing systems are especially sensitive to xenobiotics and can sustain permanent damage well below the usual dose-response if a toxic insult occurs during critical times of a developmental sequence. In addition, cleaning up hazardous sites alone will not eliminate the public health threats because children can potentially develop problems related to exposure later on.

Dr. Amler also noted that children are not in charge of their own management decisions. They depend on adults for their decisions. Dr. Amler stressed that relocation should also be considered as an impact on children's health.

Given the current life expectancy, 10,000 children born in 1998 will still be alive in the twenty-second century. The next generations will therefore be affected by policies made today. If the right policy decisions are made now, they would help babies born throughout the next century. We should change the way we think about all our regulatory and public health activities to consider children first.

Dr. Robert Amler is Chief Medical Officer at ATSDR and directs ATSDR's National Child Health Program. Dr. Amler is a recognized authority on the impact of environmental toxicants on infants and children, with more than 180 publications in the field. In addition to his extensive responsibilities at ATSDR, Dr. Amler is also a practicing pediatrician, specializing in emergency pediatrics.

Closing Session
CLOSING SPEAKER
Dr. Alan Woolf
Harvard Medical School

Dr. Alan Woolf discussed the benefits to families affected by toxic exposures from (1) three new pediatric environmental health centers established in 1998 by the Association of Occupational and Environmental Clinics and ATSDR, (2) identification of what parents want public health officials and workers to know about their children and environmental toxins, and (3) identification of the roles of health care workers in this new area of pediatric medicine.

Dr. Woolf presented a recent case study observed at the Pediatric Environmental Health Center in Boston. The case involved a 5-year-old child who moved to a suburban community northwest of Boston 2 years after he was born. The house was within three blocks of a chemical manufacturer of resins used to form plastics. There was an explosion at the plant involving styrene and acrylonitrile, followed by acrid fumes entering the surrounding homes. The children experienced coughing and irritated throats, but the families were assured that the problem had been contained and that they could stay put. One of their neighbors, an EMT involved in the state HAZMAT preparedness program, went from house to house to warn everyone to leave. After this incident, the boy's father, who had no health problems before, developed symptomatic reactive airway disease syndrome. The child developed wheezing that was controlled by steroids and bronchial dilators. The boy is in an early intervention program for neurodevelopmental problems. The boy's pediatrician admitted that he had no knowledge of the effects of the chemicals and stated that he doubted the child's health problems were associated with toxic exposure. He referred the child to the Pediatric Environmental Health Center. At the end of the 1½ hour visit to the center, the mother said that it was the first time someone listened to the parents and thanked them.

Three pediatric environmental health centers have been established and are located in Boston, Massachusetts; Seattle, Washington; and Mount Sinai, New York. The centers were established to familiarize pediatricians and occupational and environmental medicine workers in cross-training between the two subspecialties. The centers also disseminate information on pediatric environmental toxicology to pediatricians and the community. Finally, the centers provide service to affected families by conducting telephone triage in conjunction with poison control centers. Their assessment of the child fulfills the paradigm discussed earlier by Dr. Krantz with regard to the methyl parathion exposure: a careful environmental history is taken, and a judicious physical examination is performed. The centers also try management approaches to address parental concerns, offer further diagnostic consultations, and perform advocacy roles.

Dr. Woolf reminded the audience that every parent wants public health workers to know that they live in a chemical society. The Poisindex, used by most poison centers in the United States, contains information about over 550,000 toxins. The Chemical Abstract Service (CAS) has recorded over 750,000 chemicals. NCI knows of at least 1,200 suspected or potential carcinogens. Dr. Woolf stressed that parents know that risks exist; however, they may evaluate risks differently from scientists.

Finally, Dr. Woolf outlined roles of health professionals, including surveillance of cases that may represent hazards to the entire community. In addition, public health workers have data collection and analysis responsibilities to advocate legislative and policy changes, as well as responsibilities related to educating patients and the public about emerging environmental health threats to children, program coordination, and community outreach and organization.

Dr. Woolf concluded by stating that he is optimistic that the emergence of new child health initiatives and the formation of partnerships will enable public health professionals to realize a safer world for children and a lasting legacy for future generations.

Dr. Alan Woolf is an Associate Professor of Pediatrics at Harvard Medical School. He is Director of the Program in Clinical Toxicology and Co-Director of the Pediatric Environmental Health Center at Children's Hospital in Boston. His research interests include the epidemiology of poisoning and the identification of high risk populations, and he has more than 120 publications in the field.

Closing Session
CLOSING SPEAKERS
QUESTIONS AND ANSWERS

Priority Issues

Ms. Mary Lee Holton (Michigan Department of Environmental Quality) stated that the Children's Health Protection Advisory Committee (CHPAC) had five different priorities than the four that Ms. Trovato described for the Presidential Task Force. The latest report lists the five priorities of CHPAC as being related to asthma, mercury, atrazine, farm worker protection standards, and organophosphate pesticides. Ms. Holton asked how these groups interacted and whether there was sufficient funding for all of these priorities.

Ms. Trovato responded that the priorities that Ms. Holton cited were specific tasks that the Office of Children's Health Protection asked CHPAC. EPA Administrator Browner committed to reviewing five existing regulations to determine if they address children's health protection, and OCHP asked CHPAC to provide a list of priority issues. The five issues cited by Ms. Holton are not CHPAC's list of priorities but rather CHPAC's answer to one of OCHP's questions. Last week, CHPAC decided to begin a strategic planning initiative to identify other important areas. CHPAC primarily interacts with EPA because CHPAC was formed to advise EPA.

Ms. Holton asked whether the Task Force consists of a different group of people.

Ms. Trovato clarified that the Task Force is made up of various government agencies, including the Departments of Education, Labor, Justice, Agriculture, Office of Management and Budget, EPA, Department of Health and Human Services, and several others. The purpose of the group is to list the federal government's priorities and develop a plan to address these priorities. CHPAC, on the other hand, primarily consists of nonfederal people and was tasked to advise EPA children's health issues.

Referrals to Centers and Clinics

Ms. Mary Lee Holton (Michigan Department of Environmental Quality) asked if she should make referrals to the Boston Pediatric Environmental Health Center if someone from Michigan called her with a toxic exposure concern.

Dr. Woolf agreed that she could refer the person to the Boston center. The telephone call would be answered by nurses or pharmacists trained in clinical toxicology. They would attempt to answer questions over the telephone or devise a plan to obtain the answer.

Dr. Amler stated that initial funding of the centers was limited and that funds should be obtained to establish a center in each of the federal regions (for example, Region 5 would have its own center). Dr. Amler stressed that in cases of acute exposure and immediate and disturbing symptoms, the appropriate route of referral is an emergency room or a Poison Control Center. Immediate problems require immediate solutions.

Ms. Louise Fabinski added that there are three Association of Occupational and Environmental Clinics (AOEC) in Michigan in Detroit, Lansing, and Ann Arbor. In addition, state health departments in the region also have a cooperative agreement with ATSDR and have ATSDR's emergency number in Atlanta, where a team can be formed if necessary.

Ms. Kathy Kirkland (Executive Director of AOEC) stated that there are AOEC clinics in 28 states, Washington DC, and three provinces. Five clinics are in Michigan. She encouraged people to call her for more information about the clinics.

Cut-Off Age for Lead Poisoned Population

Ms. Maurci Jackson asked how the 11 communities were chosen for the Child Health Champion campaign pilot study. Ms. Jackson also asked if 6 years was the cutoff age for consideration in the study with regard to childhood lead poisoning and cancer.

Dr. Amler stated that EPA and ATSDR do not draw a line at age 6. He clarified that in terms of childhood cancer, beginning around age 14 and 15, many children do not get referred through pediatricians or pediatric cancer centers.

In response to the first question, Dr. Ramona stated that the 11 communities were chosen by the ten EPA regions. The only limitations placed on the selection process were that the communities had to be diverse and include Native American, agricultural, rural, and urban communities. In addition, communities were chosen based on their relationships with the states so that new relationships would not have to be established. Also, the communities had to want to participate. It was not a competitive process. The goals of the pilot program are to determine what works and what does not work.

Environmental Education

Ms. Lynn Katz Chary commented that she found it important to take people, especially women and mothers, seriously when they approach pediatricians and public health officials about their problems. She stated that the grassroots movement contains many examples of women who went to professionals about their problems and who were dismissed immediately as hysterical housewives. Ms. Chary stated that the next crucial step is to educate other health care professionals starting in medical school and that environmental history should be part of the curriculum. She stated that she would like to see more initiatives from the government and funding agencies with regard to this issue. In addition, Ms. Chary stated that she wanted to see more professional associations like the American Medical Association (AMA) represented at conferences like this one.

Dr. Woolf acknowledged that those elements that Ms. Chary described have been missing for a long time. He added that part of the new initiative by ATSDR and AOEC involves cross-training and empowering health professionals and members of the public.

Ms. Trovato responded that EPA agreed with Ms. Chary completely. EPA has begun working with the National Environmental Education Training Foundation and AMA to try and change the medical school curriculum to include these issues. EPA is also working to incorporate environmental education into training for nurses.

Dr. Amler stated that a comprehensive environmental medicine curriculum is now required in all pediatric training programs. The new concept is that when a child leaves a hospital, it is not just a hospital discharge but also an admission to the community and to the home that the child lives in. Everything from environmental history to good discharge planning will be included in the new curriculum. Dr. Amler stated that EPA and ATSDR are working with the Children's Environmental Health Network and the Association of American Medical Colleges to train pediatric residency program directors in how to set up this type of curriculum.

Child Health Champion Initiative

Mr. Tim Soucy (Manchester, New Hampshire, Health Department) commended EPA for undertaking the Child Health Champion Initiative and encouraged EPA and ATSDR to continue working with local public health agencies. He acknowledged them as the "front line folks" in the public health fight.

Ms. Trovato stated that EPA is continuously learning how to do place-based work and that EPA is looking forward to finding out what the communities need most from the federal government.

Evaluation of Programs

Mr. Jonathon Ramlow (Dow Chemical Company) asked how ATSDR and EPA would be evaluating the success of their initiatives, the timeframe used to measure success, how the findings would be reported, and whether there would be feedback loops into program implementation.

Dr. Amler responded that for the President's Task Force, evaluation is one of the three program implementation areas that is now being designed. ATSDR is looking at some of the parameters, such as how many children have access to expert pediatric referral.

Ms. Trovato stated that for the 11 pilot communities, a large evaluation scheme is built into the program. The evaluation is different depending on each community.

The Role of Public Aid

Ms. Beverly Comar (Chicago Community Networker) asked what is being done to get SSI and public aid to be effective in enabling citizens, particularly those in houses that are disabling them, to get whatever medication is necessary so that they can participate in a training program or meet an employer's schedule.

Dr. Amler stated that it is a question of how to institutionalize the ability to diagnose, treat, and follow-up on environmentally associated conditions in the way we currently do for infections and other types of problems. He stated that if a person has heart trouble and had heart surgery, it would be covered by most insurances unless the procedure was very experimental. At the present time, work is still needed on the procedure codes and details of what should be covered by insurances, including the federally funded insurances.

Ms. Trovato stated that HUD spent $50 million in 1998 to mitigate the lead problem in public housing. EPA is working with HUD to enforce lead regulations that require landlords, home sellers, and real estate agents to notify people when they buy or rent a place where lead is present. While EPA cannot require people to test for lead, it can require that people divulge information if lead's presence is known. EPA is working on an enforcement initiative related to this issue.

Mold

Ms. Comar asked whether EPA is addressing the mold problem that is prevalent in Illinois, particularly in public housing. Ms. Comar added that mold causes hostility and learning disabilities, symptoms similar to those of lead and PCBs.

Dr. Amler stated that the health effects of mold are well known. Exposure to a toxigenic mold had been reported several months earlier; it caused babies to almost die because of to bleeding in their lungs.

Educating Elected Officials

Ms. Maureen Headington (Director on the Board of Illinois Environmental Council) asked how elected officials are educated about these issues.

Dr. Amler responded that government employees brief elected officials on various programs and projects and have very well defined relationship with elected officials. Government employees in a way that makes it possible for elected officials to make their own decisions.

Ms. Trovato added that EPA conducts technical briefings on Capitol Hill to inform elected officials about EPA programs.

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